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TABLE OF CONTENTS

PRELIMINARY PERFORMANCE TEST BATTERY OF ORIENTATION, MOBILITY, AND LIVING SKILLS

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The rehabilitation literature is replete with articles pertaining to various aspects of orientation, mobility, and living skills.[1] There is, however, a dearth of research in these areas, and virtually no objective evaluations of programs designed to teach skills to blind students (Ashcroft and Harley, 1966; Lowenfeld, 1963, ror reviews). The lack of evaluation is not unique to programs for the blind. It tends to prevail throughout the field of education to such a degree that recent congressional appropriations have precipitated an "evaluation crisis" (Reynolds, 1966).

The purpose of this paper is to evaluate objectively a workshop held at the Oregon State School for the Blind in which the principal goals were to teach youngsters rudimentary living skills and the techniques used in precane orientation and mobility.[2,3] The chief criterion used in searching for evaluative instruments was that they constitute performance measures of relevant program goals. Evaluation would have been easier if a battery of performance tests covering a broad range of orientation, mobility, and living skills had been available. However, a review of the literature revealed that there are very few objective tests of orientation and mobility. Moreover there is neither any reference to a battery of orientation and mobility tests, nor a truly objective measure of living skills.[4]

Since the pioneering work of Hayes (1948), which had its origin about 1918, the literature on testing of blind persons has burgeoned with various measures of educational achievement, intellectual ability, personality, and vocational aptitude.[5] However, Lende's (1953) selected compilation of more than 120 articles on tests constructed or adapted for use with the blind does not include any annotated reference to performance measures of orientation, mobility, or living skills. Although not directly relevant to the present study, reference is made to Buell's (1950) comprehensive work with the problem of measuring gymnastic motor performance. Faced with such an evaluation crisis, the authors were forced to compromise. In brief, their compromise was that of developing a battery of relevant performance tests, while attempting program evaluation in the same time period. In addition, the available options for experimental design were very limited; the results we can report here are accordingly very much affected by these constraints. Two main limitations of this paper result from the fact that the test battery itself was developed during the program evaluation period, and that the changes in performance reported may not be attributed to the program being evaluated, since there were no control groups used.

The first direct approach to obtaining a performance measure of

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mobility appears to be in a New York Institute for the Education of the Blind publication (1945) which includes instructions for administering and scoring the Room Orientation Test. Obstacle courses have been used by investigators interested in human (Supa, Cotzin, and Dallenbach, 1944 review; Ammons, Worchel, and Dallenbach, 1953) and mechanical (Zahl, 1962; Worchel, Byrne, and Young, 1966) detection of obstacles. Other studies, while stimulating construction of several useful research instruments--e.g., Sheridan's (1963) Obstacle Course, Harris, Dupress, Wright, Curtis, Winer, Gropper, and Kelsey's (1963) Head Position Test and Street-Crossing Decision Behavior, and Jones' (1963) Triangle Test--have done little in clearing the way toward a battery of performance tests for orientation and mobility. The Room Orientation Test would have been useful in the present study; however, the above instruments are not readily available and none of them could be acquired prior to the present study. Thus the construction of some appropriate measuring instruments was requisite to evaluating the Workshop.

RESEARCH INSTRUMENTS

Orientation Mobility Test Battery (OMTB)

Although not intended as an ad hoc research instrument, the OMTB, comprised of 21 performance tests directed toward a selected range of orientation, mobility, and living skills, was developed specifically as an evaluative tool for the Workshop.[6] The tests were written from a list of about 90 skills relevant to program goals that had been prepared by the school staff. The skills covered a broad spectrum ranging from general, dormitory, and off-campus orientation and mobility, to social skills and orientation in the cooking and dining areas.

Before an instrument is employed for evaluative purposes its capabilities should be demonstrated. The instrument should identify and measure consistently the phenomena in question. To establish these capabilities, of course, requires considerable pilot work. Unfortunately there was no time to pilot study any of the OMTB subtests. Therefore, the feasibility of measuring the students' proficiency in orientation, mobility, and living skills depends largely on the validity of the *approach* used in deriving the subtests. It may also be said that the process of establishing the validity of an instrument involves the use of the instrument in some "shakedown cruise" experiences. Thus, the development of an instrument for evaluative purposes requires that the instrument be employed in some simulated evaluative exercises--exercises which provide preliminary information both about the instrument and about the phenomena under scrutiny.

It is assumed that adequate measures of orientation, mobility, and living skills are founded on behavior rather than on subjective interpretation of behavior. The behavioral approach, as employed in writing the subtests, involves the conceptualization of measures which are as close as possible to *being* the real behaviors ultimately sought. In this context the behavioral approach directs one to abstract and study *components of the ultimate behavior expected* rather than certain behaviors which may only be presumed to relate to the ultimate behavior expected. Accordingly, an appropriate test must contain behaviorally determined and specifically defined response categories. The tester is then required only to observe and score behavior according to the response categories. This approach has "face" validity. No hypothetical construct, subjective interpretation, or clinical judgment is involved.[7]

Based largely on this assumption, the rationale and criteria used in constructing the tests were as follows: (a) to maximize the potential for obtaining face validity and objective scoring, only those skills with discrete behavioral referents were included; (b) to obtain reliable measures the theoretical scoring ranges were made as wide as practicable, either by developing several response categories or grid-like scoring units, or by increasing the number of trials. The response categories were considered, a priori, delineative of behavior characteristic of poor through good performance. An unweighted numerical value was then assigned to each response category, scoring unit, or trial.

The OMTB covers two broad areas of performance: orientation and/or mobility, and rudimentary living skills. The names of the tests give some indication of the behavior which the test was designed to measure. Nevertheless a few expository comments are required to communicate the nature of the task. The comments will first be directed toward the orientation mobility tests and then toward the living skills tests.

The first two tests, Right-Left (turns) and 90° Turns, were administered and scored simultaneously. Students were asked to make ten 90° turns, five to the right and five to the left.[8]

Success on the Squaring-Off Test requires knowledge of the relative position of two objects. When squaring off, one must align and orient himself with one of the objects, then use the information obtained to walk to the other object. To measure the subject's ability to square off, two chairs were placed 15 feet apart; he was led to both chairs, walked in a figure eight, and then asked to walk from one chair to the other.

In the Walking-a-Line Test each subject was asked to walk a straight line, and told to stop as he crossed a line seven feet from the point where he began walking. Then to get an estimate of the subject's ability to judge a short distance, he was asked how far he had walked.

On the above tests, scoring units were marked on the floor. Thus scores were determined by the placement of subjects' feet relative to the boundaries of the scoring units.

The Maze had six cul-de-sacs, three opening toward each end. Grid squares were marked on the floor within each cul-de-sac. The "errors" represent the number of grid squares in which the subject stepped. Subjects were to traverse the maze four times, twice in each direction. The sound of a metronome, which was placed at the goal, was used as an intramaze-orienting cue on the first three trials; the metronome was not used during the fourth trial. To minimize the potential advantage from practice in traversing the maze, it was arranged in the post-test in an approximate mirror image from the pretest arrangement.

In the Up-Down Test, subjects were asked to point up five times and down five times; then they were asked to point up twice and down twice, alternating the direction pointed and hand used with each trial.

The names of the living skills tests are more revealing in terms of the task requested. All subjects were asked to locate a pair of their socks; zip and unzip a jacket; button and unbutton a coat; cover a bed with a blanket; hang a coat on a hanger; wash their hands; identify a knife, fork, and spoon; pour water from a pitcher into a glass; set a table; and turn on specific stove burners.

Subjective ranks

Subjective data were also obtained from listings of subjects' names in alphabetical order under the following instructions:

"Proficiency. Please rank the children listed below according to their present proficiency in orientation and living skills.[9]

To place the children in rank order, give a rank of 1 to the child who is the most proficient, a rank of 2 to the child who is second most proficient and so on through the entire list.

Do not collaborate with another staff member in ranking the children. Please rank each child and *do not give the same rank to more than one child.*

Improvement. Please rank the children listed below according to the amount of *improvement* in orientation and living skills that in your judgment they have shown throughout the workshop.

Place the children in rank order for improvement. For example, give a rank of 1 to the child who has shown the most improvement, a rank of 2 to the child who has shown the second most improvement and so on through the entire list.

Please rank each child and do not give the same rank to more than one child."

METHOD

Model

When evaluation is included in program planning, it is much easier for the psychologist to design an experiment which allows him to exert some control over the data he obtains. This control may in turn make the results of an experiment more conclusive and more meaningful to the practitioner. But practical considerations frequently limit the choice of experimental design. In our study it was not practicable to assign students randomly to different treatment conditions, or to expose them systematically to two different conditions, workshop and no workshop. Thus, each subject was used as his own control in a one-group pre- post-test design. This design allows one to state whether a change does or does not occur, but one cannot say that the change can be attributed to training or independent variables. Interpretation of the changes noted must take this limitation into account.

Subjects

The staff compiled a list of 30 students, including those referred from other agencies, who were considered to be lacking orientation, mobility, and living skills. They were often characterized as relatively younger and less experienced, or older with more need for such skills, than the norm. Final selection narrowed down the list to children who the staff felt to have the most need. Letters were written to the parents of 24 potential students, inviting them to enter their children in the workshop. Sixteen attended (12 Oregon State School for the Blind students, 4 referred from other agencies). The ages ranged from 11 to 20, with a median of 13.25 years. There was an equal number of boys and girls. One of the students had light perception in both eyes; the rest were totally blind. Other than blindness, none had any severe physical disability, nor did any show behavior problems.

Training

The training variables may be described through the various activities conducted during the Workshop. The time period involved was three weeks, except for weekends when the students went home. The 16 students were divided into four groups of four each. Assignment to a group was made by subjective judgment of proficiency in orientation, mobility, and living skills. In an attempt to provide a broad range of ability within groups, each group was composed of one student with high, one with low, and two with intermediate entrance (pre-test) skill levels. Thus the members of each group were judged to comprise a heterogeneous subpopulation regarding proficiency in orientation, mobility, and living skills.

Each day, every group attended two 45-minute orientation and mobility classes, two 45-minute living skills classes, and one 3-hour culinary practicum. The groups were combined for one hour of supervised recreation, one 45-minute activity period, and a one-hour social competence class. Evening activities were varied and usually unstructured.

Orientation and mobility. The orientation and mobility classes were taught by two mobility instructors, each teaching the same two groups of students throughout the Workshop. Precane skills suited for group teaching were stressed; for example, basic techniques such as trailing, following a sighted guide, using landmarks and shorelines, cross body protection, taking verbal directions, extending arms obliquely to detect lower obstacles, using auditory and olfactory cues, and squaring off, were emphasized. In addition, the instructors drilled students in practical applications of directional concepts such as north, south, east, west, up, down, left, and right. Students also practiced using the precane techniques to explore an unfamiliar environment systematically, and to learn to traverse familiar environments.

About one-fourth of the total class time was spent with two groups meeting together, i.e., eight students and two teachers. During the combined class meetings students were given instruction in reading raised maps. They located familiar routes on the map and they were introduced to other routes which were then traversed on foot. The advantages of using raised maps in teaching orientation and mobility have been discussed by several writers (e.g., Gilson, Wurzburger and Johnson, 1965; Langan, 1953).

Although the Workshop was not designed to offer training with the cane, two of the top students were introduced to basic cane techniques. Since they were eager to work with the cane, the teachers offered the lessons as a reward for completing class assignments. They were given six lessons in the basic (Hoover technique) grip, hand and arm position, and wrist action. All of the lessons were given in a hall 8 feet by 86 feet.

Living skills. The living skills classes were conducted by four teachers, one for each group of students. The scope of these classes was quite broad, ranging from basic self-care skills associated with personal hygiene, dressing, and grooming, to more advanced skills such as maintaining personal belongings. The former included training in specific tasks such as brushing teeth, using deodorant, tying shoes, buttoning, zipping, and combing hair, while the latter included labeling, folding, washing and hanging clothes, shining shoes, and ordering personal belongings so that they could be easily located. In addition, basic housekeeping skills, including dusting, bed making, and operating tank and upright vacuum cleaners, were emphasized.

Culinary practicum. The practicum was conducted in four different but similarly equipped kitchens, one for each group. After a general orientation to the cooking and dining area, preliminary tasks such as budgeting, menu planning, and shopping were undertaken. The groups budgeted and planned their menus in accordance with the limits imposed by a weekly food stipend. Teachers accompanied the groups on semiweekly shopping trips. Each student selected his groceries from a brailled list and paid for them at the checkout counter. Other elements of home cookery, including storing, labeling, preparing, and serving food were practiced daily. Clearing the table, washing dishes, sweeping, and mopping were the chief post-prandial chores.

Other Activities

Each group, including the teacher, participated in a weekly discussion led by a psychologist. While these sessions were conducted with a relatively nondirective approach, students were encouraged to explore feelings about themselves and others within the group through various techniques of psychodrama. They discussed and played roles in various situations, including unpleasant encounters with sighted people. Similar groups were occasionally conducted by counselors in the dormitories.

All 16 students attended the social competence class, which was a contracted service provided by a self-improvement and models agency. They were encouraged to express opinions and ideas, but a directive approach was used in presenting the elements of etiquette, posture, and decorum.

During the recreation period, provision was made for swimming, bowling, dancing, and roller skating. Evening activities included parlor games, socials, and some attention to living skills essential to room care and to prepare for activities planned for the next day.

Testing

OMTB. The entire battery was administered twice to each student. Pre-testing was completed on the fourth day of the Workshop. Post-testing began three days before the end of the Workshop. This left only seven complete days of training between the pre- and post-tests.

Subjective Ranks. At the close of the Workshop six staff members ranked the students twice, once for *proficiency* and once for *improvement* of orientation and living skills. Staff members frequently discussed the progress of students during coffee breaks and daily staff meetings. The sharing of observations about students was encouraged, but the importance of assigning rankings independently was also stressed.

RESULTS

Proficiency in orientation, mobility, and living skills, as these are reflected in students' post-test scores, was analyzed in relation to (a) pre-test scores, (b) staff rankings for proficiency, and (c) staff rankings for improvement. Since there were no hypothesized performance differentials, two-tailed tests were the statistic of choice. Hence all the analyses were sensitive to decrements and increments in performance, and to negative and positive relationships.

The first and major step of data analysis was in assessing differential pre- and post-test performance (Guilford, 1956, p. 183 ff.). Ordering data in this manner showed whether or not there were any significant differences between the students' test performances at the beginning and at the end of the Workshop. These data are summarized in Table 1. With the exception of the four analyses of maze data, all of the differences were in a positive direction. Five of the positive differences were significant (Squaring Off, Hanging, Pouring, Setting Table, and Lighting Stove), whereas the four negative differences were not significant.[10]

Before any meaningful comparison of the staff's rankings with test scores can be made, the extent to which staff members agreed in ranking students must be established. The coefficients of concordance (Siegel, 1956, p. 229 ff.) among the staff's proficiency ($W = 0.89$) and improvement ($W = 0.40$) ranks were significant at the 0.001 and 0.01 levels respectively, indicating very close agreement in ranking students. Thus, staff members were each using essentially the same criteria when ranking students. As with any subjective rating, however, high levels of agreement imply nothing about *what* criteria they may have been using. It does *not* mean that the rankings are *correct*; agreement would also be high if rankings were made on the basis of some inappropriate or *wrong* external criteria. These limitations on the interpretation of subjectively derived data may raise the question, "Is there any relationship between the staff's composite rank ordering and the students' rank order as determined by their performance on the OMTB?" Or, "Are the staff members using any behavior measured by the OMTB as criteria for ranking students?"

To answer this question, the correlations between (a) the OMTB post-test scores and the staff's ranks for proficiency and (b) the OMTB distributions of differences and the staff's ranks for improvement, were computed. The former data are presented in Table 2. The staff's proficiency rankings were significantly correlated with 12 of the 21 tests--one at the 0.10 level, five at the 0.05 level, two at the 0.01 level, and four at the 0.001 level. These figures indicate that there is a significant relationship between the order in which staff members rank students for proficiency, and the order in which staff members rank students for proficiency, and the order in which students rank in performance on each of the 12 post-tests. The staff's rankings for improvement were significantly correlated with three of the tests: one (Maze B--A "errors") at the 0.10 level and two (Locating Socks and Lighting Stove) at the 0.05 level. Thus, there is little relationship between staff rank ordering for improvement and ranking based on the distribution of differences obtained from the pre- and post-tests.

DISCUSSION

Before discussing the results, we should like to make a few comments about the performance measures. Our discussion will be directed first toward the OMTB, then toward the data presented in the results section.

TABLE 1

Theoretical Scoring Range, Means, Standard Deviations, Standard Errors of Differences, and Critical Ratios in the Analysis of Differences between Pre- and Post-OMTB Scores

Name of Test	Theor. Range	M_1	SD_1	M_2	SD_2	M_d	SD_d	SE_dM	t
Right-Left (turns)	0--10	9.37	1.41	9.62	1.05	0.25	1.48	0.38	0.66
90° Turns	0--40	22.81	8.84	23.87	11.90	1.06	15.11	3.90	0.27
Squaring Off	0--8	6.12	2.20	7.00	1.27	0.88	1.63	0.42	2.10*
Walking a Line	0--4	2.44	1.12	2.94	1.03	0.50	1.37	0.35	1.43
Judging Distance	0--7	3.87	2.06	4.19	1.94	0.32	0.98	0.25	1.28
Maze A--B "errors"	0--44	4.87	3.10	6.54	5.21	1.67	6.25	1.67	1.00
Maze A--B (time)	0--240	101.80	44.78	122.20	59.84	20.40	46.90	12.54	1.63
Maze B--A "errors"	0--44	4.34	4.11	6.00	5.76	1.66	4.27	1.14	1.46
Maze B--A (time)	0--300	141.27	83.85	149.80	94.16	8.53	76.14	20.36	0.42
Up-Down (pointing)	0--10	9.69	0.85	9.81	0.73	0.12	0.48	0.12	1.00
Up-Down (right-left)	0--8	7.37	0.99	7.87	0.33	0.50	1.22	0.32	1.56
Locating Socks	0--4	3.62	1.85	3.75	0.56	0.13	1.27	0.33	0.39
Zipping Coat	0--4	2.50	0.87	2.81	1.07	0.31	0.85	0.22	1.41
Buttoning Coat	0--8	6.94	1.71	7.06	1.98	0.12	2.06	0.53	0.23
Covering Bed	0--18	13.62	3.46	13.87	3.69	0.25	2.88	0.74	0.34
Hanging Coat	0--4	2.56	1.58	3.19	1.33	0.63	0.96	0.25	2.52**
Washing Hands	0--5	4.50	0.87	4.69	0.77	0.19	0.53	0.14	1.36
Identifying Flatware	0--9	8.94	0.24	9.00	0.00	0.06	0.24	0.06	1.00
Pouring Water	0--78	47.50	13.15	60.19	16.60	12.69	20.33	5.25	2.41**
Setting Table	0--12	3.12	3.67	5.00	4.30	1.88	2.47	0.64	2.93**
Lighting Stove	0--10	3.56	2.23	5.44	3.48	1.88	3.06	0.79	2.38**

Note: Upper-scoring limits for the Maze tests are the worst scores attainable, whereas upper limits for all the other tests are the best scores attainable.

*Significant at 0.10 level.

**Significant at 0.05 level.

TABLE 2

Rank Order Correlations (Significance Tested by Student's *t*) between OMTB Scores and Staff's Proficiency Ranks for Orientation and Living Skills

Name of Test	rho	*t*
Right-Left (turns)	0.28	1.07
90° Turns	0.60	2.82[b]
Squaring Off	0.39	1.61
Walking a Line	0.51	2.21[b]
Judging Distance	0.02	0.09
Maze A--B "errors"	0.44	1.82[a]
Maze A--B (time)	0.86	6.36[d]
Maze B--A "errors"	0.84	5.88[d]
Maze B--A (time)	0.93	9.31[d]
Up-Down (pointing)	-0.28	1.09
Up-Down (right-left)	0.16	0.62
Locating Socks	0.52	2.27[b]
Zipping Coat	0.51	2.25[b]
Buttoning Coat	0.37	1.48
Covering Bed	0.72	3.88[c]
Hanging Coat	0.71	3.77[c]
Washing Hands	0.38	1.52
Identifying Flatware	0.00	0.00
Pouring Water	-0.17	0.64
Setting Table	0.77	4.54[d]
Lighting Stove	0.58	2.64[b]

[a]Significant at 0.10 level.

[b]Significant at 0.05 level.

[c]Significant at 0.01 level.

[d]Significant at 0.001 level.

OMTB

Each of the subtests could be discussed at length. In view of the primary purpose of the present paper, this aside will be limited to remarks on a few of the OMTB's more prominent strengths and weaknesses.

The lack of pretesting of the OMTB has affected the data obtained. Thirteen of the subtests have theoretical scoring ranges of 10 or less, which restrict the score variance and thus the potential for measuring changes in performance.

In some instances the small scoring range is imposed by the nature of the behavior in question. For example, skills such as hand-washing, zipping, buttoning, locating, and hanging clothes do not develop in widely varying degrees of proficiency. More refined measurement would require the development of precise measures of muscular or spatial behavior, e.g., extending the early work investigating sighted children's dressing skills (Wagoner and Armstrong, 1928).

Other tests with small scoring ranges--Squaring Off, Walking a Line, and Judging Distance--could be improved easily by refining the scoring system. For example, the number of scoring units and the distance from A to B might be increased in the Squaring-Off Test. Such modifications would render the test sensitive to a wider range of proficiency.

The eight tests with theoretical scoring ranges of more than 10 could also be improved. For example, a better method of scoring the Maze Test would involve marking the entire floor into grid squares, and assigning a minus value to those squares in cul-de-sacs and a plus value to those squares in the most direct route from A to B. A student's *error* score for any given trial would then be the algebraic sum of the plus and minus grid squares he stepped in. This scoring method would have the advantage of crediting the student who makes some progress in the maze, with some achievement, even though he does not reach the goal.

The relationship of proficiency in a maze to practical considerations of orientation and mobility is questionable, and it may be worth specific investigation. Certainly a maze does not replicate many characteristics of the natural environment. If one assumes, however, that competence in following a maze involves the use of precane mobility techniques, and that these techniques are either a prerequisite for, or facilitate progress in mobility training, it follows that good maze performance may be associated with positive responses or success in mobility training. Accordingly, one indication of readiness for mobility training would be available. There are additional parameters of training readiness (Graham, 1965), however, that need further research. The factors entering into readiness for mobility training are too numerous and complex to reduce to maze performance. Even beyond this, a body maze is not a practicable instrument for an examiner to include in his kit.

For the purpose of discussion, the research instruments have been named the "OMTB," but their preliminary nature has been stressed. Here, an explicit caveat is in order: *The OMTB is offered as an heuristic provisional instrument to interested researchers; it should not be employed as though it were a fully standardized test battery.*

Findings

While the Workshop may *appear* to have had a positive impact on the students, the lack of a control group requires a cautionary note against associating the changes in test performance with the training. Thus, neither the increments nor the decrements in performance can be attributed to the Workshop experience. Nevertheless, it is worth noting that 81 percent of the differences were in the positive direction. This is not to imply that all of the increments were significant. By chance one could expect 2 out of 21 test analyses to be significant at the 0.10 level. Thus, 1 or 2 of the 5 statistically significant differences could have turned out as significant by chance alone.

The data clearly indicate that youngsters can learn practical living skills in a relatively short period of time. The fact that a group of youngsters with a median age of 13.25 years could achieve significant performance increments on such rudimentary tasks as hanging a coat on a hanger, pouring water, and setting a table, points to a definite lack of training during their earlier years.

Examination of the acquisition of living skills, especially among primary or preschool students, could focus on questions with practical implications for teachers and administrators. The early studies, questioning whether or not skills such as buttoning, cutting with scissors, and climbing stairs are amenable to special training (e.g., Hilgard, 1932), were bound to the heredity vs. environment and maturation vs. learning controversies. Blind children do benefit from special training in such skills. Similar studies, devoid of the theoretical controversy which concerned early investigators, could contribute to answering practical questions such as, "What is the optimum age range and length of time that should be devoted to teaching specific living skills to blind children?"

The statistically significant improvement in performance on the Lighting Stove Test has rather limited implications. The task requires a simple motor skill that could be taught easily simply providing knowledge of correct response (Anderson, 1967). While working with the stoves was a new experience for some of the youngsters, knowledge of the burner controls on stoves in their own homes would not prevent a significant improvement on this task at the Workshop.

In contrast to the improvements in living skills, there was relatively little change in performance on the orientation and mobility subtests. Considering the period of time generally considered necessary to develop orientation and mobility skills, this finding is not at all surprising. More recent efforts indicate that mobility skills, particularly that of obstacle perception, can be taught in relatively short periods of time. (Cf. Juurmaa, J., Suonio, K., and Moilanen, A., 1968.) Murphy (1966) recommends that mobility courses include five and one-third weeks for teaching precane skills to students before beginning training with the long cane. In this context it is noteworthy that the increment in the Squaring-Off Test was even marginally significant. It is entirely possible that the increment would have reached a still more significant level if the test had been constructed with the modifications suggested earlier.

While close agreement between judges who ranked students for mobility performance has been noted (Jones, 1963), it is unlikely that subjective rankings based on completely *independent* behavioral observation would be so concordant as to reach a W of 0.89 ($p < 0.001$) found in the present study. The how or why of the high agreement obtained cannot be specified operationally; however, some of the agreement probably arose because the type of information asked for in the ranking task was frequently discussed among the raters. Hence the subjective rank orderings are not based on completely independent observation.

In comparing the proficiency ranks with the OMTB, the following living skills were identified as entering into the staff's rankings: locating socks, zipping a coat, covering a bed with a blanket, hanging a coat on a hanger, setting a table, and lighting specific stove burners.

Several performance measures of orientation and mobility skills were also related to the proficiency ranks, e.g., the youngsters' ability to make 90-degree turns, and to walk a straight line. To the extent that the maze data reflect global proficiency in orientation and mobility, these skills also had a definite impact on the raters. The number of errors and the amount of time taken to walk from place to place influenced the order in which staff members ranked students.

In general, the analyses of the proficiency rankings suggest that the staff gave orientation, mobility, and living skills about equal weight when ranking students. One-half of the significant correlations in Table 2 are of orientation and mobility tests; the other half are of living skills tests. Thus the data indicate that students can be ranked subjectively for proficiency with very high agreement, and that the standards used in assigning ranks are fairly discrete orientation, mobility and living skills.

Although the subjective rank orderings for improvement were significantly correlated with distributions of differences on three of the subtests, only one of these tests--Lighting Stove--showed a significant increment in performance. Thus there is little, if any, relationship between subjective rankings for improvement and objective measures of improvement. This finding is not surprising; the reliability of differences has historically vexed the social sciences.

It is even difficult to account for the close agreement among improvement rankings when the complexity of the task is considered. In essence, when obtaining ranks for improvement, the rater is asked to rank mentally all students for proficiency before training; then to rank all students for proficiency after training while giving careful attention to preclude the occurrence of ties from the resulting pre-post difference ranks; then to obtain the difference in rank order for each student; and finally, to list the students according to the magnitude of the differences. The question, "Was the staff ranking for proficiency while intending to rank for improvement?" could be raised. One rejoinder would be to pose its antithesis. A more appropriate method of obtaining subjective rankings for improvement would be to compute the differences between proficiency rank orders assigned before and after training.

The pre-post method of obtaining subjective ranks is suggested only for the interest it holds in comparison with objective measures. It is not recommended as a measurement technique. The lack of appropriate performance measures has already shown up among many evaluative and correlational studies, in which conclusions are based on subjectively derived data.

As long as proficiencies in orientation, mobility, and living skills are subject to analysis as dependent variables, there should be a demand for objective measures of these skills. There is presently a very definite lack of such measures available. The present study has demonstrated the feasibility of developing a battery of performance measures to fill this need.

SUMMARY

Blind children, median age 13, attended a three-week Workshop of daily classes in orientation, mobility, and living skills. Twenty-one preliminary performance tests were developed to evaluate the Workshop. Students achieved significant increments in performance on four of the living skills tests and on one of the orientation mobility tests. Staff members were in close agreement when ranking students for proficiency and improvement in orientation and living skills. Comparison with performance measures indicated that staff gave about equal weight to orientation and mobility and to living skills when ranking students for proficiency. There was little relationship between subjective ranks for improvement and distributions of differences obtained from pre- and post-test scores. The feasibility of developing a performance battery of orientation, mobility, and living skills was demonstrated.

NOTES

1. The need for more precise vocabulary has been stressed by Conner (1964). Others have offered personal (Whitstock, 1962) and usual (Kenmore, 1960) definitions for orientation and mobility. Webster's dictionary (1961) defines orientation as ". . . the act of determining one's bearings or settling one's sense of direction." Mobility is defined as ". . . the capacity or facility of movement." The terms are not interchangeable but good mobility is contingent on and thus implies orientation.

2. The present study was supported by Title 1, PL 89-10, State Project #259. The writer is grateful to David G. Berger for his consultation throughout every phase of the study, and to Vernon O. Tyler, Jr. for critical reading of the manuscript. To a large degree, the authors are indebted to Charles C. Woodcock, Superintendent, and the staff of the Oregon State School for the Blind for their support and suggestions which facilitated construction of the performance measures.

3. While summer workshops have been conducted at Oregon State School for the Blind since 1962, the prototype of the present workshop had its inception somewhat later (Zesche and Woodcock, 1964). Since 1964 there have been two workshops each summer; one for precane students and one for students using the long cane.

4. F. E. Lord (Los Angeles State College) is developing the California Scale of Orientation and Mobility which presently includes many items concerning living skills. The Preliminary Scale, which is administered in interview form, is currently undergoing revision to render it more objective (Lord, 1966). Cratty and Williams (1966) are developing a battery of orientation and mobility tests. However, the writer was not aware of their work at the time this paper was written.

5. The most recent development is a battery of four vocational and personality tests, and two interview aids. The vocational tests cover spatial concept formation, tactual perceptiveness, and manual dexterity. The personality tests are projective techniques--auditory and sentence completion. The interview aids are for diagnostic and personal-history-type interviews. A brochure describing the battery is available from: Tests for the Blind, c/o The Champion Press, 7710 Old Springhouse Road, Westgate Research Park, McLean, Virginia 22101.

   In addition L. F. Hanley (University of Boston) is developing a braille reading readiness test that is expected to become available during the fall of 1967 (Hanley, 1967).

6. A copy of a 7-page Preliminary Manual including details for constructing, administering, and scoring the OMTB may be obtained from ASIS National Auxiliary Publications Service, c/o CCM Information Sciences, Inc., 909 Third Avenue, New York, New York 10022. Order NAPS Document No. 01329, remitting $2.00 for microfiche or $5.00 for photocopies.

7. We use the term *face validity* in the following sense: ". . . The extent to which the test is made up of items that to casual inspection seem related to the variable to be tested. This is hardly validity at all, though it may contribute to having a test accepted" (English, H. B. and English, A. V. *A Comprehensive Dictionary of Psychoanalytical Terms*. New York: Longmans, Green and Co., 1958, p. 576). An alternative, and perhaps happier choice of term might be *content validity*.

8. In each test involving trials and alternative requests,

e.g., right or left, the alternatives were incorporated into the instructions in either a random or irregular order.

9. Unfortunately the instructions did not direct the rater to rank for *mobility*. This omission, while potentially confusing, probably had little if any effect on the ranks. It is, however, a prime example of imprecise vocabulary.

10. Four levels of significance are being reported: (a) 0.10, (b) 0.05, (c) 0.01, (d) 0.001.

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A Preliminary Manual for the Orientation-Mobility Test Battery

This manual is offered as an heuristic and provisional instrument. It should not be employed as though it were a fully standardized test battery.

RIGHT-LEFT TURNS

Administration

S stands on a circular piece of plywood, 1/2 by 36 in., which is marked into octants (Figure 1). Align *S*'s feet with footprints so that the leading edge of his heels coincides with the horizontal line. "I am going to ask you to make some right-angle turns." Assure *S*'s understanding of a right-angle turn. Use a book to illustrate. "Sometimes I will ask you to turn to the right and sometimes I will ask you to turn to the left. When you turn I would like you to make right-angle turns. Do you have any questions? Turn: left; right; left; right; left; right; right; left; left; right." Before each command, align *S*'s feet on the footprints.

Scoring

(a) (0 to 1 per trial for direction of turn) Score 1 each time *S* turns in the direction instructed. Score 0 if *S* turns in opposite direction or does not turn. (b) (0 to 4 per trial for degree of turn) The score for each turn is determined by referring to numbers in the octants of the circle (Figure 1). Score each foot according to the octant in which it is placed. If in question about a score, use the toe of the shoe as a guide. Then score according to the octant in which more than half of the toe appears to be placed. Score each turn 0 to 4.

SQUARING OFF

Description

Two chairs are placed so that chair A is against the wall and chair B is 15 ft. from chair A. Eight scoring units, each 9 in. wide extend laterally from each side of B. One scoring unit, 18 inches wide, coincides with B (Figure 2). Narrow masking tape may be used for marking all the scoring units.

Administration

Take *S* to chair A. "Here is a chair. Now I'm going to show you another

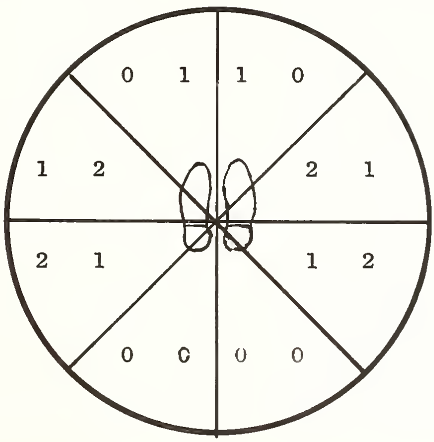

Figure 1. Right-Left Turn scoring key. Numbers to the left and right of the vertical line are used to score left and right *turns*, respectively. Within octants, numbers on the left and right are used to score the left and right foot, respectively.

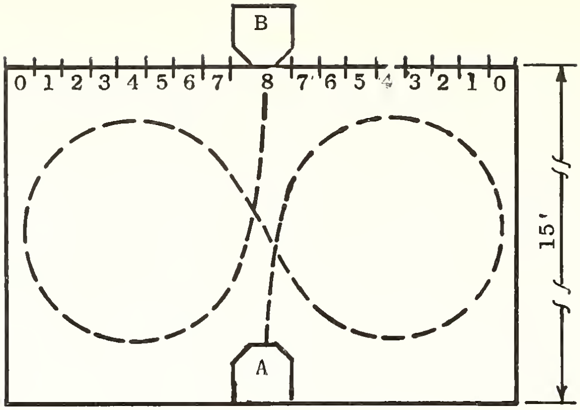

Figure 2. Squaring-Off scoring key. Score according to directions in text.

chair. Then I will ask you to walk from this chair to the other chair." Allow *S* to examine chair A. He may sit in it but do not suggest that he do so. Take *S* to chair B and then walk him in a figure eight (as indicated by the broken line in Figure 2 before taking him back to chair A. "Now go to the other chair." If necessary, encourage *S* to walk until he reaches or is lateral to B.

Scoring

(0 to 8) Score according to the unit in which *S* is standing or walking when he passes or reaches B. The score is determined by the lower unit within which more than half of *S*'s foot appears to be placed. Thus to achieve a score of 8, both feet must be within the unit scored 8. If *S* does not walk until he is lateral to B, score 0.

WALKING A LINE

Description

The *S*'s task is to walk a straight line, A to B, using a wall to square off. Nine scoring units, each 9 in. by 7 ft., are marked on the floor. The middle unit is defined as the straight-line area (Figure 3).

Administration

Align *S* at A with heels against the wall and one foot on each side of the line bisecting A. "When I say 'Go,' you are to walk a straight line, straight out from the wall. I'll tell you when to stop and then ask how many feet you have walked. Ready, go." Tell *S* to stop when he has walked 7 ft.

Scoring

(0 to 4) Score according to the lowest unit in which *S* places an entire foot, e.g., if *S*'s foot overlaps the straight-line area,

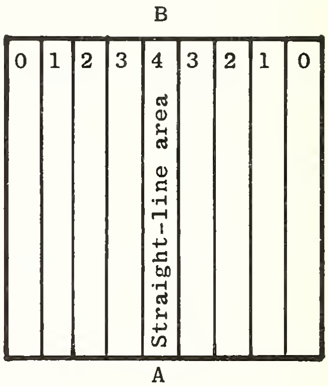

Figure 3. Walking-a-Line scoring key. Score according to directions in text.

but does not fall completely within the unit scored 3, then *S* receives a score of 4. If *S* does not walk to B, score 0.

JUDGING DISTANCE

Administration

As soon as the Walking-a-Line Test has been administered, ask "How many feet did you walk?"

Scoring

(0 to 7) The scoring interval is 0.9 ft. Score 7 if *S*'s answer is from 6.5 to 7.4 ft. The score decreases to 0 in direct proportion to the size of *S*'s over- or underestimate. For example, score 6 if *S*'s answer is either 5.5 to 6.4 or 7.5 to 8.4 ft.; and so on in decrements of 1.0, scoring 0 if *S*'s answer is less than 0.5 or more than 14.4 ft.

MAZE

Description

Only a general description of the maze is written because it is very unlikely that it could be reconstructed even if a figure and a detailed description were presented. The maze, measuring approximately 6 ft. by 30 ft., was bounded by bookcases on one side and a wall and windows on the other. The windows were always open and the investigators made no attempt to control or vary extramaze cues. The maze was constructed by arranging bookcases, cabinets, desks, tables, and a piano bench so as to form three cul-de-sacs opening toward one end (A), and three opening toward the other end (B). There were seven grid squares marked in the cul-de-sacs opening toward A, and seven in those opening toward B.

Each *S* was to traverse the maze four times, twice in each direction. The sound of a metronome was used as an intramaze-orienting cue on the first three trials. No particular sound was introduced during the fourth trial.

Administration

Prior to each trial, align *S* at the starting point so that he is facing the goal. Allow *S* in maze only during timed trials.

Trial 1: A to B with metronome at B. "Stand here while I walk toward the other side of the room. When I get to the place where you are to walk, I will turn on a metronome which sounds like this." Sound metronome. "The metronome will be on a table. There will be several objects in the way but you are to go around them and continue walking toward the sound. Stand here until you hear the sound start. Then, when I say 'Go,' start walking toward it. Do you have any questions?" Start metronome at B, give *S* instructions to go, and begin timing. If *S* does not start walking within 5 sec., encourage him to walk toward the sound.

Trial 2: A to B with metronome at B. "Now that you have had a chance to locate the objects, I'd like you to walk the most direct route toward the sound. As soon as I say 'Go,' start walking toward the sound." Start metronome at B, give *S* instructions to go, and begin timing. Do not encourage *S* to start walking on this or any of the remaining trials.

Trial 3: B to A with metronome at A. "Now I'd like you to stand here for a moment while I start the metronome at the other end. This time you are to walk back to the place you just came from. Try and remember where the objects are and walk the most direct route. Start walking when I say 'Go,' and continue toward the sound." Start metronome at A, give *S* instructions to go, and begin timing.

Trial 4: B to A without metronome. "This time you are to walk back without the sound. Try and remember where the objects are and walk the most direct route. You may start as soon as I tell you. Ready, begin."

Scoring

(0 to 22 per trial) Score each trial separately. Score 1 for each cul-de-sac within which *S* places part of his foot. Score each cul-de-sac only once per trial, even if *S* should enter the same cul-de-sac more than once. Record the traverse time in seconds. If *S* does not reach the goal within the time limit--120 seconds on trials one, two, and three, and 180 seconds on trial four--discontinue and score 8, plus the number of cul-de-sac grids in which he stepped.

UP-DOWN

Administration

"Now I am going to ask you to point up and down for me several times. Point: up, down, up, down, up, down, down, up, up, down." Note and record which hand *S* uses. Start the next series of requests by asking *S* to point up with the hand opposite the one which he used on the last response of the preceding series. "Now I'd like you to point": (If *S* finished last series with *right* hand) "Up with your left hand; down with your right hand; down with your left hand; up with your right hand." (If *S* finished last series with *left* hand) "Up with your right hand; down with your left hand; down with your right hand; up with your left hand."

Scoring

For the first series (0 to 1 per trial), score 1 point for each correct response, i.e., pointing up or down with either hand, as requested. For the second series (0 to 2 per trial), score 1 for pointing correctly, up or down; also score 1 for using the hand requested.

LOCATING CLOTHES

Administration

Administer in *S*'s room. "Show me where you keep your socks." Ask *S* to pick up sock if he does not do so.

Scoring

(0 to 4) If *S*: does not locate socks, score 0; goes to three or more drawers or looks in three distinctly different places before locating socks, score 1; goes to two or more drawers before locating socks, score 2; goes to correct drawer, searches, and locates socks, score 3; goes to correct drawer and locates socks without searching, score 4.

ZIPPING

Description

A coat with a large zipper, and big enough for all *S*s, is used.

Administration

"Here is a coat with a zipper on it. Please put it on. Now, show me how you zip your coat." If *S* cannot engage zipper within 60 sec., engage it, and ask him to zip it up and down. If *S* does not zip up and down within 30 sec., discontinue and score.

Scoring

(0 to 4) If *S* does not zip up or down, after *E* engages zipper, score 0. Score 2 for engaging zipper; score 1 each for zipping up and down.

BUTTONING

Description

A coat, with large buttons, big enough for all *S*s is used.

Administration

"Here is a coat with four buttons on it. Please put it on and show me how you button your coat." If *S* cannot button within 3 minutes, button it for him. "Now unbutton it." If *S* cannot unbutton within 1 minute, discontinue and score.

Scoring

(0 to 8) Score 1 for each button buttoned in correct alignment. Score 1 for each button unbuttoned.

HANGING

Administration

Coat and hanger are hanging on hooks. "Here is a coat and hanger. Show me how you hang your coat on a hanger."

Scoring

(0 to 4) If *S*: does not hang coat, score 0; hangs coat but it falls off and he does not improve performance, score 1; hangs coat but it falls off and he improves performance, score 2; hangs coat crooked on first trial, score 3; hangs coat neatly aligned on the first trial, score 4. Discontinue and score after 90 sec.

COVERING BED

Description

A bed, 36" by 72" is marked into 18 grid squares of equal size. *S*s are asked to cover the bed with a blanket, 72" by 80". The blanket is folded in half four times and placed at the foot of the bed.

Administration

"Here is a folded blanket and here is a bed. I'd like you to cover the entire top of the bed with the blanket. Tell me when you are finished." Discontinue and score after 3 min.

Scoring

(0 to 18) Score 1 point for each grid square completely covered by the blanket.

HANDWASHING

Administration

"Here is a sink, some soap, and a towel. I'd like you to show me how you wash your hands."

Scoring

(0 to 5) Score 1 point for each of the following: wetting hands, using soap; rubbing hands together; rinsing hands; wiping hands with towel.

IDENTIFYING FLATWARE

Administration

"Now I'm going to hand you some things and I want you to tell me what they are." Hand flatware to *S* in the following presentation order: fork, spoon, fork, knife, spoon, fork, knife, spoon, knife.

Scoring

(0 to 9) Score 1 point for each item correctly identified as knife, fork, or spoon.

POURING

Description

A 2-1/2-quart pitcher with a pouring spout, and a glass 3-7/8" deep and 2-1/2" in diameter, are used. Two glassfuls of water are in the pitcher.

Administration

"Here is a pitcher with some water in it and here is a glass. Show me how you pour." Give *S* three trials and score each trial. If *S* questions the amount, instruct him to, "Pour just as though you were pouring a glassful of something to drink."

Scoring

(0 to 26 per trial) Place a ruler on the inside of the glass, against the side. The optimum level is arbitrarily selected at 3-2/8". Score 1 point for each 1/8" of water up to 3-2/8" (26 points). If the water measures more than 3-2/8", subtract 1 point for each 1/8" of "overfill." If *S* pours water on the table *or* pours the glass so full that it overflows, subtract 10 from the measured score. Thus if the glass overflows, it is always scored 11. If the glass overflows *and S* pours water on the table, score 1. If the measured score is less than 10 prior to the penalty, score 0.

SETTING TABLE

Description

Two 12" squares are drawn on opposite sides of a table. The edge of the table forms one side of each of the squares. Two, each, of the following are used: chairs, salad plates, dinner plates, glasses, knives, forks, and spoons.

Administration

Align chairs with the squares drawn on the table and push them toward the table so that the backs touch the edge of the table. Stack the tableware in the center of the table. "Here is a table and enough dishes and silverware for two people. There are two chairs placed at the table. Set the table so that two people could sit in the chairs and eat. Tell me when you are through." If *S* does not finish within 3 minutes, discontinue and score.

Scoring

(0 to 12) Each item is scored 1 or 0. Score the plate 0 if it overlaps the square. Any item that overlaps the edge of the table is scored 0. Score 1 point for each correct placement *relative* to the plate. Correct placements are as follows: Fork to the immediate left of plate, knife and then spoon to the immediate right of the plate, each forming approximately 90° angle with table edge; salad plate appears reasonably near tines of fork; glass appears reasonably near blade end of knife.

LIGHTING STOVE

Administration

"Now I'm going to ask you to turn on some stove burners. Turn on the following burners: left-rear; right-front; left-front; right-rear; left-rear; right-front; right-rear; left-front; left-rear; right-front." Do not allow *S* to hold his hand over the burners.

Scoring

(0 to 1 per trial) Score one point for each correct burner turned on.

THE ROLE OF EXPLORATORY ACTIVITY IN HAPTIC PERCEPTION: SOME ISSUES, DATA, AND HYPOTHESES*

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Some recent studies involving form perception have linked experience, changes in exploratory scanning technique, and accuracy of judgments. For example, improvements in accuracy of some tactile-kinesthetic and visual judgments of form characteristics during ontogenetic development sometimes appear correlated with developmental changes in scanning style. Similar correlations between accuracy and scanning have occasionally been revealed when blind and sighted individuals are compared.

These data suggest several important questions. First, the particular way one gathers information may influence the accuracy of his judgments. A question raised by this notion asks: Does the burden of accuracy rest with the scanning response alone, the stimulus aspect alone, or with some interaction between scanning and stimulus? Resolving this will depend on whether links shown between types of exploratory activity and accuracy can be pinned down to a specific, testable stimulus-response relationship. We need to tie accurate and inaccurate methods of scanning to the particular stimulus attributes they sample.

A second question concerns the nature of the contribution that exploratory scanning makes to perception. In other words, what makes one method better than another and what is the role of scanning in the process of information gathering?

Finally, the data emphasize a flexibility of perceptual means such that forms of attention within a means might be modified with experience. Indeed, such modifications may comprise one broad class of perceptual learning. The question of what is learned would be of some interest to both builders of theories of perception, and those concerned with improving the perceptual skills of the sensory disabled.

These issues run through several areas of research. This paper presents some experimental findings that shed a bit of light on the issues, suggesting a few avenues that future research might follow. The focus is on studies of tactile-kinesthetic perception. Haptic scanning methods can be readily observed and changes in method easily detected. In addition, it is often easy to relate particular haptic scanning methods of exploration to particular aspects of the stimulus.

A few general experimental studies have reported that the amount of active handling of an object is critical to accurate judgments of form attributes (Appelle and Goodnow, 1970; Gibson, 1962; Stanley, 1966). A representative example is Gibson's (1962) finding that active touch led to more accurate identification of form than passive touch. The task was to match forms that the subject could feel but not see. The forms were "cookie cutter" shapes about one inch in diameter. Subjects using passive touch had the shapes pressed against their open palm by the experimenter. Subjects using active exploration felt each form with the fingertips. Active handling led to 95 percent

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matching accuracy compared to 49 percent accuracy for passive touch.

Gibson suggested a general contribution is made to form recognition by active handling. Movements ". . . isolate and enhance the component of stimulation which specifies the shape and other characteristics of the object being touched" (1962, p. 478). Passive touch does not provide such information as readily. This view is in line with Gibson's general hypothesis that perception is an active process of extracting information from stimulation (Gibson, 1959, 1966). However, the experiment does not point to any particular aspect of active handling that might be critical to accuracy. In addition, the important "component of stimulation" (1962, p. 478) isolated by active scanning is not specified, so we cannot tell how scanning methods might be related to the stimulus. To answer these questions we probably have to look at studies which analyze active touch and compare the effectiveness of different methods of scanning.

An extensive study of the link between methods of exploratory activity and perception has been undertaken by a group of Russian psychologists (cf. Zaporozhets, 1961, 1965; Zinchenko and Lomov, 1960; Zinchenko and Ruzskaia, 1960a, 1960b). The Soviets view exploratory activity as playing a key role in perception. Their argument has been called a "motor copy" theory. Accurate judgments of form, for example, depend upon the availability of an adequate image of the object being viewed or handled. The image is a copy of the real object constructed by the motor movements of the eye or the hand during exploration. The more adequate the motor copy of the object, the more complete the image.

An analysis of the functions of exploratory activity within this theoretical framework has been reported by Zinchenko and Lomov (1960). Three aspects of investigatory activity can be discerned. The first is a constructive function in which the movements of eye or hand transform the contour of the stimulus into a pattern of visual-kinesthetic or tactile-kinesthetic stimulation. The second aspect involves a measuring of the extent of the stimulus or its parts. This function appears similar to Revesz's description of the use of the fingers as metrics (1950, pp. 98-100). The third aspect is a checking and correcting of the image being formed by exploring repeatedly the same stimulus elements, using different finger or eye movements. Zinchenko and Lomov emphasize that an adequate haptic image can result only from an interaction of fingers and hands performing all of these three functions. Simple single-finger tracing of a contour will lead to an inadequate image. In addition, the particular movements are organized around "reckoning off" points (1960, p. 19) on a stimulus that serve as key construction points for the image.

Several Soviet studies of improvements in perceptual skill and exploratory activity with ontogenetic development illustrate some of Zinchenko and Lomov's (1960) hypotheses. For example, Zinchenko and Ruzskaia (1960a, 1960b) studied the development of cross-modal transfer between vision and touch in judgments of three-dimensional forms. In one study (1960a), preschool children inspected a form visually, then selected its match by touch only from an array of three forms. In another study (1960b) the inspection was by touch and the recognition by vision. In both studies haptic exploration by the younger subjects (4 to 5 years old) typically involved little examination of the form's contour. "Most often, the [younger] children distinguish some separate characteristic feature. . . and examine it for a long time, not comparing it with other features of the figure" (1960a, p. 97). These subjects showed poor discrimination.

The older children (6 to 7 years old) were more accurate. Also, their haptic exploration involved attention to the contour of the form by "simultaneously grasping the figure as a whole by all fingers of the hand (*ibid*). In addition, these subjects isolated a leading feature of form in each stimulus and appeared to compare it with other aspects of the stimulus.

The inaccurate younger children explored with movements that did not "copy" the form. They did not explore the contour, the only feature that specified shape. Older subjects covered the contour simultaneously, allowing the fingers to sample a number of points on the outline at once. The isolation of distinctive stimulus features by the older children seems to be related to Zinchenko and Lomov's description of "reckoning off" points (1960, p. 19). Apparently, a subject could construct the shape by fixing the distinctive feature of the stimulus under one finger and comparing that point with others on the contour.

Some of the findings of the Russian experiments were extended in a recent study by Abravanel (1968). He found that children's accuracy in estimating length and diameter across visual and haptic modalities improved with ontogenetic development. Correlated with the improvement were specific changes in the way the child actively explored the stimulus with his hands. For example, in judging length, younger subjects "palpated, clutched, and held the bars as if. . . trying to determine shape rather than length," while older subjects "spanned the entire bar with one hand, sliding fingers from ends to center of the bar" (1968, p. 24). Abravanel suggested that accuracy in length estimation is related to the degree to which the subject actively explored the length dimension, and how much of the length could be felt at once. The increased use of fingers to span the entire length of the bar seems particularly important to this global apprehension.

Judgments of diameter were accurate at an earlier age than length. According to Abravanel, "this probably resulted from the fact that a cylinder's diameter is readily perceived by clutching it in the palm and fingers--and this is the most characteristic form of haptic exploration at the younger ages" (1968, p. 41).

So far, it appears that global or simultaneous exploration is one particular aspect of active handling that bears upon accuracy in judging form. However, the stimulus attribute focused on by the scanning also seems to matter. Let us follow up another line of evidence--comparisons of form judgments of blind and sighted subjects--to see if these conclusions generalize.

Blindness forces a reliance on active touch for form perception. This increased haptic experience sometimes leads to greater accuracy in tactile-kinesthetic judgments. More frequently, however, either the blind are less accurate than the sighted, or the two groups perform similarly. The difficulty has been in accounting for all of these results. Earlier views attributed improved accuracy of the blind to changes in the sensitivity of the receptors and accuracy decrements to a lack of visual imagery. Numerous equivocal findings have made psychologists reluctant to view blind versus sighted differences in terms of these large scale, sometimes unmeasurable, variables. The stress instead has come to fall on specific observable factors such as particular experiential differences accompanying development (Hatwell, 1966), and differences in the stimulus features sampled by the blind and sighted on specific tasks (Hatwell, 1959, 1960).

This new emphasis is reflected in several recent studies of exploratory touch in the blind. For example, a number of changes in methods of scanning braille occur as blind subjects accumulate reading experience. Critchley observed that "the expert [braille reader] performs a horizontal movement which is uniform in direction, in speed and in pressure. When a less skilled braille reader meets an unfamiliar word, his stroking touch is halted for an instant; pressure upon the symbol increases; and the transverse motion of the finger is replaced by vertical, zig-zag, or circular movements of search" (1953, p. 25). This contrast of scanning methods was amplified by tracings of touch movements in braille reading (pp. 31-32). Experienced readers' smooth sweeps indicated that they rarely explored all parts of a character. However, inexperienced subjects' frequent vertical movements showed more attentiveness to the details of each character.

Nolan and his associates have reported that differences in scanning braille may reflect a learning of locations of the most informative parts of a braille sequence (Kederis, Siems, and Haynes, 1965; Nolan, 1964). An analysis of the dots skipped by readers revealed a correspondence between frequency of misses of a particular position and the likelihood that a dot would appear in that position. The lower the probability that a dot would appear in a position the more often subjects skipped over it.

It appears from these studies that subjects experienced in gathering information with their hands may sometimes change their exploratory techniques to apprehend the most informative features of the stimulus. This hypothesis is extended in some studies of form perception by the blind. In one experiment (Hatwell, 1959), blind and sighted individuals were compared in a haptic form recognition task. The subjects explored one shape, then had to match it in an array of several forms. One comparison was made using a series of 2 centimeter by 2 centimeter squares, and another using squares 4 centimeters on a side. Blind and sighted subjects were equally accurate in identifying the smaller forms. However, the blind judged the larger ones more accurately than the sighted. Hatwell's observations of exploratory methods revealed that blind subjects used all fingers of both hands to "simultaneously apprehend the totality of the figure" (1959, p. 193). The sighted individuals used only the index finger of the preferred hand to trace around the contour of each shape.

In another study, Hatwell (1960) found that the blind were only moderately susceptible to a tactile version of the horizontal-vertical illusion. Again, the blind avoided single-finger tracing. Instead, they placed their palm on the intersection of the two lines and, using all fingers, swept the hand back and forth over the stimulus. The importance of this scanning method was checked by restricting another group of blind individuals to the use of only the index finger. This group turned out to be significantly more susceptible to the illusion.

It seems that Hatwell's blind subjects not only focused haptic attention on the most informative stimulus features, but also used scanning techniques that patterned these features simultaneously. These findings were extended in Davidson's recent comparison of curvature judgments by blind and sighted individuals (1970). The stimuli were plastic rulers (8 inches long and 1 inch wide) flexed into symmetrical curves either with the ends bent in toward the subject in convex curves or bent out away from him in concave curves. The task was to explore the curves by hand to tell if they felt convex, concave, or straight across. Davidson recorded on videotape the exploratory scanning methods the subjects used during their judgments.

The blind were more accurate at judging curvature than the sighted, a finding that has been reported before (Hunter, 1954; Pick and Pick, 1966). Moreover, sighted individuals' errors were confined almost exclusively to convex curves, while the few errors made by the blind were distributed evenly between convex and concave stimuli. Davidson further established that these convexity errors probably stemmed from a masking of the curved stimulus by the convexly shaped radial sweep of the arm during scanning.

The experiment also revealed a striking difference in exploratory style between blind and sighted individuals. The blind most often used all of their fingers at once to grip the front edge of the ruler (the surface facing away from the subject), pressing fingers against the edge and shifting the hand back and forth along it. In contrast, sighted subjects most often swept back and forth across the stimulus, either pinching it between the thumb and one or two other fingers, or feeling only the top edge with the fingertips. Davidson concluded that gripping the front edge allowed the subject to triangulate kinesthetically the ends-to-middle relationship that probably specified curvature, since this method involved feeling several points along the edge at once. The methods used by the sighted involved successive scanning, probably less efficient in apprehending a relationship among points such as curvature. In addition, gripping focused attention to a stimulus surface in a plane different from the radial sweep of the arm, a surface that may not have been masked by arm movement and could have been informative of the stimulus shape. The sighted subjects' methods, however, seemed to maximize the overlap between stimulus shape and arm movement, perhaps making judgments difficult.

What conclusions can be drawn from these studies of exploratory touch? First, accurate haptic apprehension of some form attributes may depend upon focusing attention on a stimulus feature informative of those attributes. In other words, accuracy may not be a question only of the amount of active handling of an object (Appelle and Goodnow, 1970; Gibson, 1962), but also of how the scanning interacts with particular features of the stimulus. For example, clutching the ends of a cylinder (Abravanel, 1968) involves active exploration of the stimulus, but leads to accurate judgments only of diameter. Clutching is inappropriate for length judgments because such exploration probably does not focus attention to length. Similarly, judgments of convex curves were accurate only when the scanning focused attention on a part of the stimulus which gives adequate curvature information (Davidson, 1970).

The attention-focusing function of haptic exploratory activity may have an analog in visual exploration. For example, some recent experiments have suggested that one function of visual scanning might be to select the informative aspects in a visual array (Mackworth and Morandi, 1967; O'Bryan and Boersma, 1969; Zinchenko and Lomov, 1960). It may be that the two modalities share common principles of information gathering.

A second notion ensuing from these data suggests that the most successful scanning methods seem to involve a simultaneous exploration of the important stimulus features. It may be that this sort of apprehension helps to organize successive parts of the stimulus into a whole (Abravanel, 1968, p. 44), or it may facilitate a comparison of one stimulus feature with others (Zinchenko and Lomov, 1960, p. 18).

Just why such facilitation results from simultaneous apprehension is poorly understood. One hypothesis that we are presently studying is that simultaneous patterning of shape may reduce a requirement for integrating successive inputs in memory. This notion suggests that exploratory scanning may serve a coding function in addition to its role in focusing attention. Indeed, there is evidence that memory for objects coded by touch is sometimes inferior to memory for visually coded objects (cf. Goodnow, in press), and there is a hint that such differences may be due, at least in part, to the way the objects are explored by touch. It may turn out that one important role of scanning involves the accurate coding of stimulus information for later use. This argument is not unlike the Soviet notion of motor copying discussed earlier, and it should be studied further.

The present review suggests at least another conclusion. It does seem that exploratory activity can be modified by experience. Improvements in scanning have been noted both with ontogenetic development, and with increased practice in using touch to gather information. Furthermore it appears that what might be learned is an attention to the informative or distinctive features of the stimulus, relative to the property being judged, and how these features can best be coded. These observations are in line with recent theoretical views of how perceptual learning might occur (J. J. Gibson and E. J. Gibson, 1955; E. J. Gibson, 1969). However, the question of what is learned during the evolution of exploratory activity is still far from being answered. Moreover, the nature of the learning is poorly understood. For example, we want to know what sorts of practice bring about a modification in scanning and how much practice is necessary. An understanding of the functions of exploratory activity as forms of perceptual learning may help to exploit the apparent flexibility of the haptic modality to improve the information gathering and coding activities of blind individuals. A second result would be a better understanding of the development of perceptual skill in the normal individual.

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READING MACHINES FOR THE BLIND, THE VETERANS ADMINISTRATION, AND THE NON-VETERAN BLIND

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Abstract

In this paper the history of reading-machine developments for the past half century is sketched along with reference to concurrent changes in the attitudes towards blindness and the blind, and vocational and educational advances made by the blind. It is suggested that now in 1970 there is a well defined need that certain blind people be able independently to read limited amounts of inkprint. There are also extant in 1970 several devices with either audible or tactile outputs, developed under various sponsors, permitting blind people to do just this. The need and means to satisfy it, both being present, a program is then outlined whereby one style of available reading machine could be deployed to a population of at least some 500 blind persons believed to have the potential for successfully using the system. Such devices should be immediately useful to small numbers of carefully selected blind people. They should be of value to persons in the computer industry even if to read only the "0" and "1" characters comprising some printouts. They should also help prepare users for the more sophisticated machines and perhaps telephone-connected systems expected some years from now, but should remain useful because of their portability even when other systems become widely available.

THE OTOPHONE

The advantages accuring to a blind person able to read ordinary inkprint independently surely must have intrigued Dr. E. E. Fournier d'Albe who described a "Reading Otophone" in a 1913 issue of the British journal *The Electrician*. He had been pondering instruments such as Alexander Graham Bell's Photophone for some years before, and at the Optical Convention of the United Kingdom, South Kensington, June 25, 1912, showed a device to enable a blind person to locate lights by means of sounds delivered to the ear. This early work by Fournier d'Albe is often considered the inaugural effort in the still-continuing search for a device which will give large numbers of blind people the ability to read graphic materials of their choice independently.

By 1917 Miss Mary Jameson, a British pioneer in polyphonic reading for the blind, had been introduced to Fournier d'Albe's Optophone. She has continued to use successively modernized versions of the Optophone to the present day, teaching the skill to others, and stimulating research aimed at improving the reading means available to blind persons.

Messrs. Barr, Stroud, and Fournier d'Albe were issued U.S. Patent No. 1,350,954 August 24, 1920 on the "Optophone." Brief tests and demonstrations were made in the United States in the Twenties, but the system did not gain any followers here. Miss Jameson used the machine built by Barr and Stroud for many years. In 1944 St. Dunstan's, a British organization for men and women blinded in war service, sponsored some updating improvements in the machine being used by Miss Jameson.

During World War II heightened concern over ameliorating the problems caused by blindness led in January 1944 to establishment of the Committee on Sensory Devices which tried to bring in the strengths of the technological and psychological communities to solve these problems. Polyphonic reading devices of those years included machines developed by Morton and Flory at RCA (U.S. Patent No. 2,420,716 "Reading Aid for the Blind," issued May 20, 1947), by Zworykin and Hillier at RCA (U.S. Patent No. 2,451,014 "Optophone," issued October 12, 1948), and by Zworykin and Flory at RCA (U.S. Patent No. 2,457,099 "Electronic Reading Aid for the Blind," issued December 21, 1948). Only the latter device, sometimes known as the RCA A-2 Reader, was produced in any quantity, 25 copies comprising the run. Limited trials and some formal evaluation by Dr. Wilma Donahue at the University of Michigan under VA auspices showed reading systems employing these devices to be marginal in terms of providing blind people the capability to read ordinary print independently. More work seemed indicated not only on the devices themselves but also on problems related to procurement of units, selection and training of instructors and prospective users, means of training, location of schools, and provisions for followup, maintenance, and repair.

The Veterans Administration maintained its interest in reading machines for the blind over the intervening years and on August 20, 1954 arranged the first Technical Session on Reading Machines for the Blind at Toledo, Ohio, under the chairmanship of Professor T. A. Benham. Subsequent sessions have been held when circumstances seemed to indicate the need for another meeting, the sixth and most recent having been held January 27 and 28, 1966 at the Veterans Administration Central Office in Washington, D.C. Deliberations at these technical sessions led the VA to support reading-machine research actively again when contracts were let in 1955 and 1957 with the University of Southern California and Haskins Laboratories, Inc., respectively for studies on audible outputs for reading machines. Work on improving polyphonic reading devices themselves commenced on April 15, 1957 with a contract between VA and Battelle Memorial Institute for the development and evaluation of aural reading devices for the blind. The Battelle work culminated in the production of 10 copies of a quite rugged, fairly reliable, portable Model D Optophone fitted into a standard piece of luggage, a ladies' train case. A major effort at Battelle led to a 200-hour training course comprising tape-recorded and inkprint materials based on successive improvements of their earlier 65 and 135 lesson courses.

Almost concurrently with the work at Battelle, VA-sponsored work at the now Mauch Laboratories, Inc. commenced with an August 1, 1957 contract to produce a personal-type reading machine for the blind. Still active in 1970, researchers on this contract have produced several instruments to date. In May 1967 Mauch Laboratories, Inc. delivered to the VA 6 Visotoners and 4 Visotactors, all complete sets with Colineator tracking aids and auxiliary equipment, all fitted into an attache case. By April 1969 VA owned a total of 36 Visotoner and 14 Visotactor sets. Both the Visotoner and Visotactor are direct translation reading machines, one with optophone-type audible output, the other with a tactile output. The Colineator, usable with either, aids in the tracking of these devices along lines of print. Current experimental developments at Mauch Laboratories include a recognition machine with spelled-speech output (the Cognodictor), and a hand-held tactile-output device called Digitactor.

The technological developments at Mauch Laboratories have been supplemented by blind-user oriented work at VA's Central Rehabilitation Section for Visually Impaired and Blinded Veterans, Hines, Illinois, and at The Hadley School for the Blind, Winnetka, Illinois. Mrs. Genevieve N. Miller, then Assistant Chief of the Blind Rehabilitation Section at Hines VA Hospital, attended a week-long seminar in use of the Battelle Aural Reading

Device for the blind, May 13-17, 1963 at Battelle Memorial Institute. She then served as instructor in optophone reading to Mr. Harvey L. Lauer, a staff member of the Hines Blind Rehabilitation Section. Mr. Lauer in turn instructed Miss Margaret Butow, a staff member at The Hadley School for the Blind. These early efforts were formalized in 1967 by establishing a centrally directed program at Hines, and by a contract with Hadley.

Mr. Harvey Lauer at Hines worked to make himself the most proficient polyphonic reader in the country, to train others to be instructors in the skill, to train veterans, to explore new uses for the devices, to develop recommendations for improvements, and to assess selection criteria for those interested in the skill. Miss Margaret Butow at Hadley, now also an accomplished user of the Visotoner, has developed explanatory and screening tape-recorded materials for home use to enable prospective reading machine users to acquire realistic notions of the system and of their capabilities and desires to pursue it. The first eight graduates of the Hadley course who have been able to obtain personal training at Hines VAH from Mr. Lauer have demonstrated both capability and motivation.

THE OPTACON

While the aforementioned reading machine activities were taking place, other researchers were also developing somewhat different systems. One which has been brought to a stage of development roughly comparable to that of the Visotoner is the Optacon (*Op*tical to *Ta*ctile *Con*verter) built at Stanford Research Institute, Menlo Park, California. This device will not be further discussed in this study, however, as the aim is analysis of the deployment problems for one system, the Visotoner, and production of a plan to achieve its deployment. To plan for deployment of a mix of the two instruments seems beyond the scope of the present study. Separate analyses logically should be made for the Optacon and its deployment. Some blind people, for physical or physiological reasons, may not be able to sense the output of the Optacon. Conversely others will not be able to make much of the sounds of the Visotoner. For such people the alternative machine is obviously indicated. Some blind people are thought to be tactually oriented, others favor the sonic milieu--for these groups choice of system also seems straightforward. Many of the skills associated with successful use of one type of instrument are thought to be quite transferable to other kinds of instruments: if so, learning one will not be a waste of effort should a person later change to a new instrument using the other sense or an improved version using the same one; e.g., the Visotactor was designed for Cognodictor input.

TECHNOLOGICAL AND SOCIOLOGICAL CHANGE

While the mainly technological events described above were occurring over the past half century or so, other changes strongly influencing the subject of independent reading by the blind were also taking place. These include changes in the attitudes of the sighted towards the blind, changes in the rationale of rehabilitation practices employed by counselors of the blind, and the movement of increasing proportions of blind people into and through institutions of higher learning leading to more employment and changes for employment in a variety of professional, technical and other areas where previously a blind person was rarely hired. The shift from the often beautiful Spencerian script renditions of all manner of business and professional communications to the current widespread use of typewritten, machine, and computer imprinted materials has added notably to the value of being able to read such materials independently. Even being able to read only the "0" or "1" characters which comprise some computer printouts would be of value. The general increase in literacy over the past few centuries also increases the urgency that one be able to read. Direct translation machines could be introduced to blind school children first as an extracurricular hobby for a selected few, somewhat as Miss Ann Chapman of Columbia Lighthouse for the Blind, Washington, D.C., did during the summer of 1970; and then, if successful, more students could be involved.

The two chains of events outlined above, showing the ever increasing need to read inkprint and the availability of comparatively practical systems for enabling the blind to do just this, leave us in 1970 with a well defined social need and several well engineered means to satisfy it. What seems yet to be lacking is the deployment system to get the machines capable of satisfying the need together with the people evidencing the need. It is to analyze contributing factors and to propose such a system that this paper is being written.

Successfully deployed reading machine systems for the blind will involve at least the following elements:

1. Reading machines (availability is a necessary condition, often conceived as the major goal, yet it is only a first step);

2. Distribution or deployment channels for the machines;

3. Teachers of reading machine reading;

4. Blind persons doing useful, independent reading of inkprint;

5. Servicing and maintenance facilities;

6. Ongoing research to improve the systems.

These elements plainly are not independent of one another. At current machine costs, usually in the order of one or more thousands of dollars each, reading machine proponents are hard pressed to get funds for machine procurement without having a register of identified blind persons who are prospective users. To identify such blind people has been a problem as few come forward convincingly as prospective users of machines they have not yet tried. Also the lack of machines and lack of a "student body" understandably has operated to discourage persons from investing the time and effort necessary to becoming a teacher of the skill. Small inroads into each of these difficult areas have already been made by the Veterans Administration and by Stanford Research Institute, but in each case the net result so far still is a subcritical system, one in danger of fading away if left to itself. To bring the system up to a level where it will be more or less self-sustaining, and thus a viable, practical rehabilitation tool, will require more machines, more teachers, and more students. Persons from the non-veteran blind community and workers ministering to it seem the appropriate ones to swell the numbers of students and teachers, while agencies charged with rehabilitation of the handicapped of many varying ages and backgrounds would seem to be the logical sources of necessary additional funds for machine procurement and program support. A period of joint operations thus seems indicated, the Veterans Administration supplying information, designs, some skilled personnel, and appropriate funds to meet the projected veteran client load, nonveteran agencies contributing commensurately with their clients' needs.

The question then arises as to what the scale of this joint deployment effort should be. Some factors to be considered when seeking the answer are:

1. Current experience with reading machines;

2. The size of the blind community;

3. The number of persons expressing an interest;

4. The numbers using other reading systems;

5. The number of instructors already available and potentially achievable;

6. The unit costs and totals available for the program;

7. The "absorption" rate of new machines into the community;

8. The vocational requirements for independent reading;

9. The willingness of persons to "invest" in learning present

systems when better ones are in the offing, and the appropriateness of suggesting such investment to selected blind persons and to agencies;

10. The gains achievable after mastering reading-machine system skills versus the investment necessary to achieve such skill levels;

11. The numbers really desiring to read independently;

12. The distribution of blindness with age, and the influence of age on learning a complex new skill.

These factors are neither all-inclusive nor mutually exclusive. Where a quantitative statistic seems involved, it is likely only imprecise data are available. Evaluation of some of the factors can be done only by making educated estimates.

POTENTIAL USERS

Projections indicate there will be some 500,000 "legally blind" persons in the United States in the mid-1970's. Blinded veterans with some compensable service connected condition would seem to comprise about 2 percent of this total. All members of these groups clearly are not candidates for reading machines of the kinds under discussion. Hopefully, far better solutions will become available, but these are years away from widespread deployment, and even under ideal conditions their use may require some of the same skills necessary for use of the present direct translation devices. Some who are "legally blind" are able to read with the aid of magnifying equipment, others will be insufficiently motivated to master a reading-machine system, some will lack mental or physical attributes necessary for success, others will be unable or unwilling to invest the effort necessary to acquire the skill. On the other side of the coin there are blind people who strongly desire to read inkprint independently, or who would evidence such desire given the availability of a practical reading system.

As there are only a few dozen or so users of reading machines at the present time, the scale of the inaugural deployment program should be such as to satisfy that very minor fraction of the 500,000 deemed likely to be successful users. The continuing reading-machine program for those becoming blind in the future will be smaller and strongly subject to the influences of new developments in machines and in changes in the incidence of blindness in the population. The idea of a one-shot initial effort to satisfy the backlog of blind persons never given an opportunity to have a reading machine, followed by a reduced maintenance schedule, is appealing from some viewpoints, but poses large problems related to the temporary character of the initial operations. Well-qualified staff personnel are harder to develop for temporary programs, and costs inevitably are higher. This would seem to indicate the wisdom of a more gradual attack on the bloc of current potential users than first predictions might suggest.

Assuming that there will be 500,000 legally blind people by the mid-1970's (and even this is subject to some question and has areas of invalidity), an assessment will be made of the size of the subpopulation within the 500,000 for whom reading-machine services with existing types of machines should be considered. It has been estimated that 12,000 visually impaired people use braille ("Characteristics of Visually Impaired Persons--United States--July 1963 to June 1964," National Center for Health Statistics Publication Series 10, No. 46, Public Health Service, Department of Health, Education, and Welfare). Let us say by the mid-1970's this figure could be 13,000. Just as a measure of people's willingness to learn and practice a reasonably difficult system this would seem to indicate only about 2.6 percent of our 500,000 put forth the necessary effort. Intuitively I feel we can expect effort and interest from about the same or, most probably, an even smaller percentage of the 500,000 in connection with electronic reading machines. Perhaps a population of 5000 prospective reading-machine users could be deduced by this rather elliptical reasoning. Interest in trials, perhaps first as an extra-curricular hobby, in schools or classes for blind children would seem important; all evidence points to routine use of braille by such students and alumni in contrast to very limited use by most adventitiously blinded adults.

Over a period of years inquiries and expressions of interest have been coming in to the Veterans Administration, The Hadley School, and Mauch Laboratories, Inc. An estimated 200 such independent expressions of interest have been received, not only from prospective users and workers in the field, but also from persons having commercial interests and those having only a general interest. While independent reading of inkprint by the blind is a dramatic type of story which has been brought before the public on a number of occasions, activity to introduce the system has not matched that associated with introducing braille to blind people. With more publicity and information dissemination activities perhaps the 200 inquiries would escalate to 2000 or 5000. Projecting from current experience at The Hadley School where only 10 to 20 percent of inquirers seem to materialize into good prospective users, we might deduce optimistically a population of some 1000 prospective reading-machine users.

Within the Veterans Administration the population analogous to the national projection of 500,000 comprises a field in the order of 15,000 blinded veterans. Some 12 of these veterans have so far learned reading-machine skills to a degree where they can be considered users. Admittedly this is but a start, the operation being marginal with only a few machines available and only one instructor, but it is indicative of the small number of blind people likely to be productive users of electronic reading machines of the type available. Applying the ratio of 12:15,000 to the national projection of 500,000 we might also deduce a total general population of about 400 reading-machine users from these data.

Quite roughly, then, it would seem there is a potential population in the order of a few thousands for direct translation, home type reading machines for the blind. Considering the reasoning already set forth above that the whole bloc not be serviced at once, but rather gradually, a good target figure for current planning is 1000. If we make the further bold assumption that half of these people will be tactually oriented, and half auditorily more proficient, we can come up with a total target population of 500 to be equipped with Visotoner reading-machine sets.

IMPLEMENTATION

To activate a system with 500 users we would first have to identify the select 500. Some means for doing this exist. The screening course developed at The Hadley School for the Blind could be used as one selection instrument to check both ability to learn the code and motivation to do so. In addition, an unpublished work by Harvey Lauer describes a system for arriving at a quantitative prediction of success with reading machines. This well-conceived instrument could also be applied to the selection process along with necessary interviews to determine details in each situation.

Procurement of machines and preparation of instructional means should proceed so that some students, teachers, and machines are ready at about the same calendar date. Engineering drawings in a form suitable for advertising for bids have already been prepared by Mauch Laboratories for the Visotoner set. Each set comprises a Visotoner, earphone, and rechargeable battery in a leather case comparable in size to a hard-cover book; also a Colineator tracking aid, spare battery, battery charger, and attache case for all equipment. The last (1967) unit cost of the set was $1875.00 each in a quantity of 40 (that is, 30 Visotoners and 10 Visotactors of comparable size and complexity). Costs have risen since, but economies can be expected on an order for 500 units, and a cost of $1500.00 per set, or $750,000.00 total material cost.

The people found to meet the selection criteria will probably turn out *not* to be ordinary people, but will be of an exceptional group. They will not have time on their hands and the six weeks of equivalent full time (screening course by correspondence; a minimum of two weeks and preferably longer full-time instruction; intensive part-time training and practice over a year or so) considered essential for a reading-machine learning period cannot be given by them without hardship. An instructor could probably handle three students in intensive training at a time. A nationwide faculty of 11 instructors would thus be able to give instruction to our 500 students for six weeks each over a two-year period. Personnel and support costs of about $20,000.00 per year per instructor seem correct, so the instructional staff for two years would cost approximately $500,000.00.

Instructor recruitment and development has in some degree already started, and it is felt the training of a dozen or so instructors could be done utilizing present specialists and a few yet to be more fully developed.

Just what the future will bring is hard, as usual, to forecast. Estimates as to the number of Perkins Braillers needed to satisfy the blind community's needs were far too low. Early predictions of a market for 5,000 Perkins Braillers were thought by some to be ridiculously high. The demand was such, however, that gradual increases over the 5,000 estimate failed to meet requirements, and now over 50,000 units have been distributed. The Perkins device is still being manufactured and sold, satisfying the demand created by new blind people, probably quite a few others not previously having a machine, sighted transcribers, and the foreign market. The demand for polyphonic reading machines may similarly burgeon, or it may subside with the development of improved systems enabling blind people to read independently. Nevertheless, a direct-translation device will always be smaller, more portable, and less costly than a full recognition system providing higher speed, less learning time, and less effort. Thus, like the pen in comparison with the typewriter, it may retain a concurrent role. The quantity, 500, and the time scale and level of instructor support suggested above seem accurate at this time for the reasons indicated.

FORMATION OF THE CHARPENTIER WEIGHT ILLUSION IN THE BLIND

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THE PROBLEM

Space perception by the blind is not only interesting in itself but offers useful suggestions regarding normal perception in general. The most impressive thing about the blind is their ability to walk in the street, perceiving obstacles, their distance and location, and skillfully avoiding them. In 1747 Diderot noted this phenomenon and explained it through some sensations. Since then, the perception of obstacles has been the most frequent object of studies and theorizing in the area of space perception by the blind. Perhaps the most systematic and thoroughly executed research was that of K. M. Dallenbach carried out between 1944 and 1950.[1] However, other aspects of space perception by the blind have not yet been studied adequately.

The problems of interest to us have been whether a blind person could discriminate between a large and a small box without touching them directly with his fingers, by lifting them up successively by handles of identical size. And further, if a blind person can perceive the difference in size, can experimental procedures be devised which would make such discrimination impossible?

To attack such problems experimentally, we used the Charpentier weight illusion. The Charpentier illusion depends on visual perception. Without visual discrimination of the difference in the size of two objects the illusion cannot arise. If this is the case then the Charpentier illusion cannot appear at all in the totally blind.

In 1897, J. F. Rice investigated the size-weight illusion with blind subjects using two sets of Seashore's suggestion blocks.[2] The Charpentier illusion occurred when they grasped the blocks with their fingers and lifted them one by one. In 1924, guided by N. Ach, A. Peiser carried out experiments with two blind men, aged 37 and 38.[3] He found the illusion occurred when they perceived the size difference of two boxes tactually. Now, if the blind person has not tactually perceived the difference in size, would the Charpentier illusion still appear? This was our first problem.

Second, if the Charpentier illusion still appeared without the blind person passing his hand over the boxes, the problem would be how, without visual and cutaneous cues, he could perceive the size difference merely by grasping the identical handles? By experimental investigation of the non-visual factors of size perception by the blind, we wished to see if we could produce the disappearance of the Charpentier illusion.

Third, we wished to investigate the influence of experience on size discrimination through nonvisual cues. Is there any difference in the occurrence of the Charpentier illusion among the congenitally blind and among those who were once sighted? The fourth question was the relationship between the illusion and duration of blindness. Finally, we wanted to investigate the relationship between the illusion and intelligence.

EXPERIMENT I

Would the Charpentier illusion occur in the totally blind who have no visual perception of the size differences? If the illusion does appear, how would its occurrence differ under the following two conditions:

1. The blind subject lifts up the boxes successively,

grasping the handle only,

2. The subject feels the boxes with with hands perceiving the difference in their sizes and then lifts them successively.

Apparatus

The comparative stimuli were seven 8.5 x 8.5 x 8.5 cm, black, wooden boxes, weighing 675, 650, 625, 600, 575, 550, and 525 gr. Each box had a wooden handle attached with aluminum fittings 6 cm long.[4]

Two standard stimuli were used: a black wooden box identical in size to the comparative stimuli and weighing 600 gr; the Charpentier box -- a black wooden box 23 x 23 x 9 cm, weighing 600 gr, and fitted with a handle identical to those of the other boxes.

To keep the height of the lifting movement constant a string was fixed at 34 cm above the surface of the experimental table. It was attached to two poles, 75 cm high, placed 65 cm apart.

A cushion, 47 x 10.5 x 1.5 cm in size and filled with silk wadding, was used to protect the boxes from damage and eliminate noise when the weights were put down (Figure 1).

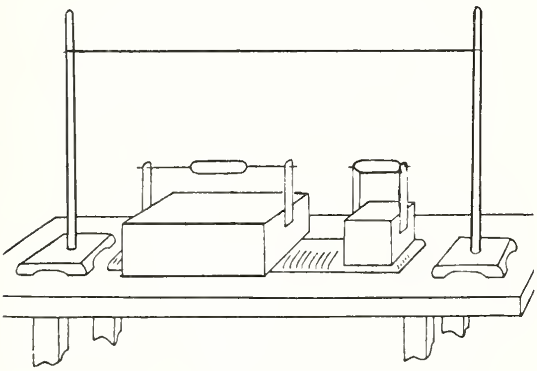


Figure 1. Apparatus for Charpentier Illusion of Weight

Subjects

The 22 subjects were pupils of the Miyagi Prefectural Blind School in Sendai, 13 male and 9 female. Their ages ranged from 12 to 26 years and their educational level from the 6th year of elementary school to the professional course level. Seven were congenitally blind, fifteen adventitiously blind. The duration of blindness of the latter was between 15 and 26 years. All subjects were either totally blind or had a very small amount of light perception. According to the Ohwaki Block-Design test for the blind their average IQ was 80.

Procedures

The weights of pairs of boxes were compared successively by the constant method. The standard and comparative stimuli were placed before the subject 7 cm apart, the standard to the right and the comparison stimulus to the left. The manner of grasping the handle was always the same. Each time the experimenter took the right hand of the subject and brought it to the handle of the box. In the same manner the experimenter guided the height of the lifting movement. The experimenter took care to avoid any contact between the fingers of the subject and any part of the box other than the handle, at this time. The subject, who had previously practiced the tempo of the lifting movement, picked up each box to the sound of a metronome at 69 beats per minute. The comparative stimuli were presented randomly. Subject lifted the standard first, then the comparative stimulus. As soon as he had put down the comparative stimulus he reported his judgment of its weight. The categories of judgment were "lighter," "a little lighter," "the same," "a little heavier," and "heavier" than the standard stimulus. When the subject was unable to feel the difference clearly, he was allowed to say so.

All the subjects compared weights under three conditions:

Experimental procedure A. The seven comparative stimuli were compared with the standard identical to them in size.

Experimental procedure B. The comparative stimuli were compared with the Charpentier box. Contact of the subject with the boxes is restricted to the handles only.

Experimental procedure C. Comparison is again with the Charpentier box, but before lifting them the subject passes his fingers over both the standard and comparative boxes. This is done thoroughly and slowly so that his tactile perception of the size difference is complete.

Results

Whether the Charpentier illusion also appears in the totally blind can be determined by comparing the results obtained in Procedure B with those obtained in Procedure A.

Table I shows the results for Procedures A, B, and C. Table 2 shows the differences between A and B.

Table 1

Weight Judgment of Each Subject

	Procedure A (standard stim.)			Procedure B (Char. stim.)			Procedure C (direct touch)		
Subj.	h	e	l	h	e	l	h	e	l
1	13	2	6	14	2	5	19	1	1
2	7	10	4	12	7	2	16	4	1
3	13	3	5	14	5	2	14	2	5
4	12	3	6	11	4	6	18	1	2
5	10	4	7	11	4	6	19	0	2
6	9	5	7	13	5	3	15	4	2
7	13	2	6	12	1	8	14	5	2
8	7	5	9	16	5	0	11	3	7
9	7	7	7	12	4	5	13	6	2
10	12	4	5	11	5	5	9	8	4
11	10	7	4	14	6	1	17	3	1
12	8	6	7	14	6	1	18	3	0
13	8	3	10	15	1	5	11	4	6
14	8	4	9	12	3	6	12	4	5
15	10	0	11	9	3	9	12	6	3
16	15	1	5	18	2	1	20	1	0
17	7	3	11	10	5	6	18	3	0
18	7	4	10	10	4	7	11	6	4
19	8	5	8	13	3	5	14	3	4
20	12	1	8	12	1	8	20	0	1
21	11	3	7	15	2	4	17	4	0
22	3	7	11	12	5	4	16	0	5
Total	210	89	163	280	83	99	334	71	57

h = heavier
e = the same (sometimes not clear)
l = lighter

Table 2

Comparison of Procedure B with Procedure A

Subj.	H	e	l	
1	+1	0	-1	
2	+5	-3	-2	
3	+1	+2	-3	
4	-1	+1	0	x
5	+1	0	-1	
6	+4	0	-4	
7	-1	-1	+2	x
8	+9	0	-9	
9	+5	-3	-2	
10	-1	+1	0	x
11	+4	-1	-3	
12	+6	0	-6	
13	+7	-2	-5	
14	+4	-1	-3	
15	-1	+3	-2	x
16	+3	-1	-4	
17	+3	-2	-5	
18	+3	0	-3	
19	+5	-2	-3	
20	0	0	0	x
21	+4	-1	-3	
22	+9	-2	-7	

Let us first examine the results of Procedure A. On the average, the number of judgments of "heavier" is greater than that of "lighter." That is to say, the negative time error is seen in the blind just as in the sighted.

However, in individual cases we find subjects 8, 9, 13, 14, 15, 17, 18, 19, and 22, whose judgments have shown no negative time error. This is remarkable. In two subjects in particular, 9 and 19, the number of the judgment "heavier" is the same as that of "lighter." In addition 8, 14, and 15, indicated the number of two of the judgments to be nearly the same. These results seem to show that the perception of weight in the blind is much more exact than that of the seeing person.

Does the Charpentier illusion occur in the totally blind, even if he has not touched the boxes directly with his fingers? In Procedure B the smaller boxes were judged heavier oftener than the big Charpentier box. The value of negative time error is much greater than that for Procedure A (Table 2). However, the subjects 4, 7, 10, 15, and 20 are exceptions. In them there is almost no difference between two procedures.

Occurrence of the Charpentier illusion is clear in 21 out of 22 subjects. Nevertheless in subjects 11, 12, and 16 the judgment "lighter" occurred only once. It has not occurred at all in subject 8.

The results indicate that the blind in some way have perceived the difference of the size of the boxes, even though they have not directly passed their fingers over them.

In Procedure C, we let the subjects touch the two boxes thoroughly with the fingers of both hands before lifting them up one by one to compare their weights.

The comparative results are seen in Table 3. The Charpentier illusion appears very strongly, with the exception of subject 10. These results coincide with those of James F. Rice and A. Peiser.

Table 3

Comparison of Procedure C with Procedure A

Subj.	h	e	l
1	+6	-1	-5
2	+9	-6	-3
3	+1	-1	0
4	+6	-2	-4
5	+9	-4	-5
6	+6	-1	-5
7	+1	+3	-4
8	+4	-2	-2
9	+6	-1	-5
10	-3	+4	-1
11	+7	-4	-3
12	+10	-3	-7
13	+3	+1	-4
14	+4	0	-4
15	+2	+6	-8
16	+5	0	-5
17	+11	0	-11
18	+4	+2	-6
19	+6	-2	-4
20	+8	-1	-7
21	+6	+1	-7
22	+13	-7	-6

In further comparison, we find that the Charpentier illusion occurs more strongly in Procedure C than in Procedure B. Although the blind could discriminate the difference in size without directly feeling the boxes with their fingers, they could perceive the difference more accurately where they could pass their fingers directly over the boxes. Consequently the Charpentier illusion had to occur more strongly in Procedure C than in Procedure B.

Is there any difference in the occurrence of the Charpentier illusion between the congenitally and adventitiously blind? This problem has not been studied so far. Seven congenitally blind subjects and fifteen adventitiously blind comprised the small and unequal group. The experimental results are shown in Table 4. The figures in the table are averages for each judgment category.

The difference between the procedures is shown in Table 5. It is remarkable that in Procedure A, the congenitally blind show no time error: the number of judgments "heavier" and of "lighter" is almost equal. On the contrary, the adventitiously blind show time error just as the normal. These results seem to indicate that the weight perception of the congenitally blind is superior to, or more exact and stable than, that of the adventitiously blind.

The differences between the results of Procedures B and A, show the occurrence of the Charpentier illusion in the blind without any direct contact with the boxes. Also, we find a greater degree of the illusion in the congenitally blind than in the adventitiously blind. These results suggest that the congenitally blind perceive the size difference of two boxes more skillfully than the adventitiously blind.

Table 4

Procedure Judg. S	A			B			C		
	h	e	l	h	e	l	h	e	l
Congenitally *n* = 7	8.4	4.3	8.3	12.4	3.6	5.0	13.6	3.4	4.0
Adventitiously *n* = 15	10.1	3.9	7.0	12.9	3.8	4.3	15.9	3.1	2.0

Table 5

Procedure Judg. S	B-A			C-A		
	h	e	l	h	e	l
Congenitally *n* = 7	+4.0	-0.7	-3.3	+5.2	-0.9	-4.3
Adventitiously *n* = 15	+2.8	-0.1	-2.7	+5.8	+0.8	-5.0

In Procedure C the Charpentier illusion occurred slightly more in the adventitiously blind than in the congenitally blind. In the latter, the difference in the quantity of Charpentier illusion between Procedures B and C is small. These results tend to show that the congenitally blind can perceive the size difference merely through the movement of lifting the boxes up and down, without touching them. In Experiment II we shall explore more closely the cues for this size discrimination.

Observation of the adventitiously blind seems to indicate a great difference in the memory image of visual space between those who were blinded before four years of age and those who lost their vision later. Therefore, we added to the congenitally blind group all those subjects whose blindness occurred prior to four years of age and retained in the adventitious group only those blinded at a later age. In Tables 6 and 7 we compare the Charpentier illusion for the two groups thus formed.

If we compare the Charpentier illusion for both groups in these tables the previously observed tendency is found again, and we may affirm that the Charpentier illusion occurs in the congenitally blind with greater ease and frequency than in the adventitiously blind.

Nevertheless, the difference between the congenitally and adventitiously blind is small. Testing for significance of the difference of the results of the three procedures and between the congenitally and adventitiously blind, gives us the figures shown in Table 8.

The difference between procedures A, B, and C is significant at the 1 percent level. The difference between the congenitally and adventitiously blind is not significant even at the 5 percent level.

Table 6

The Congenitally Blind (Blinded Before 4 Years Old) and the Adventitiously Blind (Blinded After 4 Years Old)

Procedure	A			B			C		
S / Judg.	h	e	l	h	e	l	h	e	l
Congenitally $n = 13$	8.7	4.1	8.2	12.3	3.7	5.0	14.0	3.5	3.5
Adventitiously $n = 9$	10.8	3.9	6.3	13.3	3.8	3.9	16.8	2.9	1.3

Table 7

Procedure	B-A			C-A		
S / Judg.	h	e	l	h	e	l
Congenitally $n = 13$	+3.6	-0.4	-3.2	+5.3	-0.6	-4.7
Adventitiously $n = 9$	+2.5	-0.1	-2.4	+6.0	-1.0	-5.0

Table 8

Analysis of Variance According to Table 4

Source	Sum of Sq.	Df.	Mean Sq.	F.
Diff. btw. procedure	2585.7	2	1292.8	24.58
Diff. btw. cong. and advent.	296.8	1	296.8	5.64
error	105.2	2	52.6	--
total	2987.7	5	--	--

Qualitative Results

In experiments with blind subjects it is essential, in addition to the quantitative results of the experiment, to listen to their spontaneous comments and introspections while observing their behavior. This often provides information regarding the results, and reveals hidden problems. The following are some comments and introspections of subjects during Procedure B.

Subject S is a boy in the first year middle school and congenitally blind. The experimenter has been careful to keep him unaware of the size differences in the boxes. In spite of this the subject said spontaneously, "This one is heavier although it is smaller," and inclined his head strangely several times. When asked by the experimenter how he knew there was a big box and a smaller one, he immediately replied, "The larger one sounds as if it were empty when it is put down, while the smaller one sounds as if it were filled with something. So I realized the difference in size." The experimenter himself is unable to hear such sounds, much less to discriminate between them.

Subject K, a congenitally blind girl in the first class of middle school, reported that she felt the larger one ". . . seemed light and flimsy, while the smaller one seemed gentle and calm. Therefore, I could tell the size difference."

Subject H, a boy blinded at the age of eight, is now in the 2nd class of middle school. "I recognized the bigger and the smaller one by the wind when I lifted up the boxes. When I lifted up the larger one a strong wind rose up, while when I lifted up the smaller one, there was no wind. Besides, I could hear the sounds when I put down the boxes, and I could feel the difference of response in my hand when I put them down."

Similar experiences were often reported, but we found some other characteristic introspections.

Subject K: "When I lifted up the larger one, I felt as if my hand got somewhat twisted." This experience resulted from the fact that he did not grasp the handle exactly at its center.

Subject A: "When I lifted up the larger one I felt that the sleeve band of my coat slightly touched the box, while with the smaller one it did not, so that I had not such a feeling at the sleeve." The wooden handles were of different lengths. There were a few subjects, who became aware of the difference through such touch sensation against their coat.

There were some subjects who could not explain it in words but had discriminated the size of the box in some way.

We have found no clear differences between the introspections of the congenitally blind and the adventitiously blind.

Experimenters Observations

The blind in general seem to be not quite at ease, when they are not touching something, so that their hands and fingers move continually. Therefore the experimenter took great care not to allow the subjects' fingers to touch the boxes. When the boxes were of nearly the same weight, and the difference hard to discriminate, the subjects tried to lift them up not with five fingers as instructed, but with only one finger to compare them. This tendency was especially strong when the subject assumed the experiment was a test of his ability. To report "equal" or "not clear" seemed to him a confession of his inability to perform the task. Consequently he would endeavor to avoid such judgments. We therefore assured the subjects frequently that the experiment was not a test of their ability, but of standard values of weight sensation.

Summary of Results of Experiment I

1. The Charpentier illusion occurs in the totally blind if they have become aware of the different volumes of the boxes by examining them thoroughly by touch with their fingers.

2. The blind are able to discriminate the size differences of the boxes without direct exploration by touch.

3. The totally blind seem to be able to discriminate the size of the boxes through very faint auditory and very subtle, indirect touch sensations.

4. A difference in the negative time error of judgment was found between the congenitally and adventitiously blind.

5. The difference in the Charpentier illusion occurring in the congenitally and adventitiously blind is not statistically significant.

EXPERIMENT II

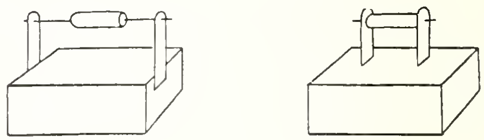
In the first experiment we found that the Charpentier illusion occurs in the totally blind, without either visual or cutaneous perception of the difference between the boxes. From the subjects' introspections and the experimenter's observations it appears that the difference is perceived through faint, below threshold sounds and indirect subtle touch or muscular sensations. In the second experiment we wished to ascertain whether the Charpentier illusion would disappear if we could eliminate such faint auditory cues and subtle, indirect touch sensations. By means of such experimental procedure we wanted to confirm objectively the sensory basis for spatial perception of volume in the blind.

In the first experiment we had not been able to discriminate clearly and significantly between the weight perception of the congenitally and adventitiously blind, nor had we established any relation between IQ and the Charpentier illusion. We undertook to investigate these areas in our second experiment.

To supplement the results of the three experimental procedures in Experiment I, we added a fourth experimental procedure in which verbal information was given regarding the size of the boxes. This was to test whether the Charpentier illusion would occur through verbal suggestion alone.

Apparatus

The stimulus boxes were the same as those in Experiment I, but the handle was improved (Figure 2). The fittings attaching the handle to the box were made of the same size as those on the other boxes. The cues produced by accidental contact between the subject's sleeve and the different fittings were thus eliminated.



1st experiment 2nd experiment

Figure 2

The other cues revealed by the introspective reports were the faint sounds and muscular sensations in their hands as the subjects put the boxes down on the cushion. To eliminate these auditory and indirect muscular cues the boxes were suspended from a wire stretched at the height of the subject's chin. Strings 16 cm in length were attached at either side of the handles. These in turn could be attached to hooks on the wire (Figure 3). Thus after each box had been lifted for comparison and then returned to its former position it was still suspended in the air. Sounds or muscular sensations of resistance related to replacing the box on the cushion were no longer produced.

Procedures

The use of a metronome was abandoned. We found it excited the curiosity of some subjects and distracted their attention from the comparison of the weights. Some also had considerable difficulty in coordinating the lifting movements to the metronome sounds. Therefore, instead of using the metronome, the experimenter now called out "One, two, three, four." The tempo of the calls remained close to that of the metronome in Experiment I, and the subject's lifting movements were timed by them. For Procedures A, B, and C, the same pattern of comparisons was followed as in Experiment I. In Procedure D the Charpentier box was not used. Both the standard and comparative boxes were of the same size. However, the subject was informed that one box was larger than the other. The placement of the standard stimulus in all four procedures in Experiment II was randomized to avoid a possible space error. In Experiment I the standard had always been placed on the right side of the subject.

Subjects

Pupils of the School for the Blind in Sendai who had been subjects in Experiment I, were at first used in elaborating the design for Experiment II. During this preparatory work it was found that these subjects had attitudes and expectations, derived from their experiences in Experiment I, regarding box sizes, etc. To avoid a contamination of the results it was decided to carry out Experiment II with entirely new subjects from a different school. The subjects used were pupils of the Iwate Prefectural Blind School in Morioka, about 160 km from Sendai. There were 21 subjects, 13 male and 8 female. Their ages ranged from 13 to 29 years and their

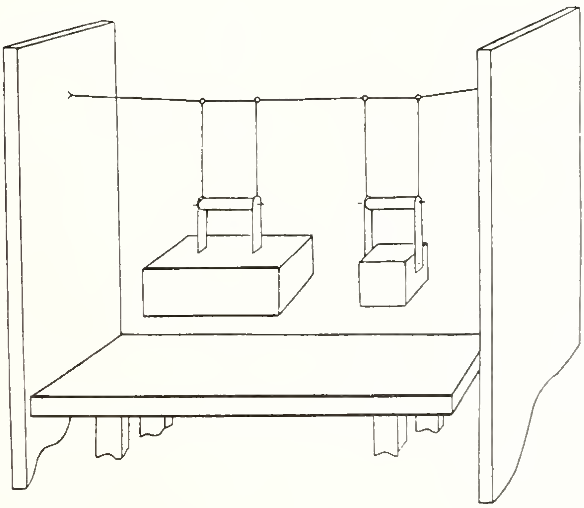


Figure 3

educational level from the 6th grade of primary school to the 1st year of the professional course. Age of subjects at onset of blindness was as follows: 6 congenitally, 7 between two and four years, 5 between ten and sixteen years and 3 at sixteen or later. Their average IQ was 90, 10 had IQ over 100 and 11 below 100. IQ was measured by the Ohwaki Intelligence Test for the Blind. The average IQ of 90 was a little higher than that of the Sendai subjects. All but two subjects were totally blind. They were all living in a dormitory. The experiment was performed in October 28 to 31, 1956.

Results

Table 9 shows the comparison judgments for each subject. Table 10 shows the average number of judgments in each category. Table 11 shows the differences between the average judgments obtained with Procedure A and each of the other procedures.

We can see from Tables 10 and 11 that there are no large differences between Procedures A and B. That is to say no Charpentier illusion has been produced in comparing the large Charpentier box with the small boxes in Procedure B. We have succeeded in eliminating the occurrence of the Charpentier illusion through the avoidance of the faint subliminal sounds and light resistance sensations in the hand. This makes it clear that when the Charpentier illusion appears without direct grasping of, or tactual contact with the boxes, it is based on the ability to discriminate between the large and small box by means of subliminal auditory cues and slight muscular sensations.

In contrast, with Procedure C, the judgments of "heavier" increase overwhelmingly and the judgments of "lighter" decrease. The Charpentier illusion has been produced by the direct tactile inspection of the two boxes, just as it had been in Procedure C in Experiment I.

Table 9

Judgment of Each Subject

Procedure	A			B			C			D		
S \ Judg.	h	e	l	h	e	l	h	e	l	h	e	l
1	8	3	10	11	0	10	20	0	1	14	2	5
2	10	3	8	8	4	9	13	3	5	14	2	5
3	9	1	11	9	2	10	19	0	2	17	0	4
4	10	2	9	9	1	11	16	2	3	16	1	4
5	8	4	9	5	6	10	11	1	9	12	3	6
6	9	4	8	8	5	8	15	2	4	14	3	4
7	10	3	8	10	2	9	12	5	4	13	5	3
8	8	4	9	12	3	6	19	2	0	14	3	4
9	10	4	7	12	2	7	14	6	1	13	5	3
10	9	3	9	12	2	7	20	1	0	10	5	6
11	6	5	10	7	5	9	14	2	5	17	3	1
12	8	4	9	8	2	11	10	1	10	9	4	8
13	12	2	7	8	6	7	11	1	9	9	2	10
14	11	1	9	8	1	12	16	3	2	16	2	3
15	9	3	9	7	3	11	14	4	3	13	2	6
16	10	0	11	8	2	11	16	2	3	10	4	7
17	12	0	9	13	0	8	17	0	4	13	0	8
18	12	2	7	13	6	2	16	2	3	15	2	4
19	13	1	7	11	3	7	16	0	5	13	0	8
20	11	3	7	13	1	7	16	4	1	15	4	2
21	15	5	1	2	7	12	11	9	1	11	8	2
Total	210	57	174	194	63	184	316	50	75	278	60	103

Table 10

Procedure / Judg. / S	A h	A e	A l	B h	B e	B l	C h	C e	C l	D h	D e	D l
n = 21	10.0	2.7	8.3	9.2	3.0	8.8	15.0	2.4	3.6	13.2	2.9	4.8

Table 11

Procedure / Judg. / S	B-A h	B-A e	B-A l	C-A h	C-A e	C-A l	D-A h	D-A e	D-A l
n = 21	-0.8	+0.3	+0.5	+5.0	-0.3	-4.7	+3.2	+0.2	-3.4

Under Procedure D, where the boxes were of the same size but the experimenter suggested verbally that one was larger than the other, the Charpentier illusion appeared with considerable strength.

Through all procedures judgments of "equal" varied by only ±0.3, which is almost constant. This tendency is nearly the same as for Experiment I.

The Charpentier illusion and age at onset of blindness. In terms of age at onset, we classified our subjects into two groups. The first group, composed of the congenitally blind and those who lost their vision between birth and four years of age, numbered 13. The second group contained all those blinded after the age of ten years and numbered 8 persons. In Tables 12 and 13 the weight judgments of the two groups may be compared.

The perception of weight is generally very similar in the two groups, especially under Procedures C and D. However, under Procedure A, the first group shows no time error, while the second group does. These results are quite consistent with the results of Experiment I. Group I subjects in Procedure B show no time error either; the Charpentier illusion does not occur. Group II does show a time error. However, this time error is a little smaller than that for Procedure A, so that it cannot be regarded as the effect of the Charpentier illusion, but as the effect of time error alone. The effect of the Charpentier illusion is strikingly apparent in Procedure C in both Group I and Group II.

The statistical significance of the differences obtained is analyzed in Table 14. There is a significant

Table 12

Procedure / Judg. / S	A h	A e	A l	B h	B e	B l	C h	C e	C l	D h	D e	D l
Group I	9.2	2.9	8.9	8.8	3.2	9.0	14.7	2.3	4.0	12.8	3.2	5.0
Group II	11.4	2.4	7.2	10.0	2.8	8.2	15.6	2.5	2.9	13.9	2.4	4.7

difference at the 5 percent level between procedures. But we find no significant difference between the congenitally and adventitiously blind groups.

The results from Procedure A indicate that the weight perception of the first group is more exact and stable, while that of the second group is less so. The adventitiously blind, especially those who were blinded after the age of 15 years, are inaccurate in the perception of weight differences. This is clearly shown by a comparison of their judgments with the objective weights.

We classified the subjects into more finely differentiated groups with respect to the age of onset of blindness. This resulted in the following four groups:

Group 1 - congenitally blind	6
Group 2 - blinded between ages two and four years	7
Group 3 - blinded between ten and fifteen years of age	4
Group 4 - blinded at sixteen years or later	4

Table 15 shows the results of Experiment II tabulated according to these four groups. Differences between procedures are shown in Table 16.

Having classified the subjects into these more finely differentiated groups, it becomes clear that there is scarcely any difference between the first, second, and third group. In contrast, the fourth group, those who lost their sight at sixteen or later, differ considerably from the first three groups. Under Procedure A they already have 7.4 errors, on an average. Consequently, under Procedure C, when they have perceived the size difference thoroughly by direct touch, the Charpentier illusion can only show a very low value. As can be seen from Table 16, the same is true for Procedure D. When we examine their judgments in detail, we find their weight perception to be inexact and erroneous. They often made incorrect judgments in comparing the 600 gr. and 525 gr. boxes; an error which was not made by even a single subject in groups 1, 2, or 3. Subject 21 even completely reversed the judgments between Procedures A and B (see Table 9). Therefore, it is not safe to judge the difference between the congenitally and adventitiously blind on the basis of statistical analysis alone. If we contrast the typical congenitally blind with the typical adventitiously blind, such as those in group 4, we may conclude the following: the adventitiously blind are remarkably inferior to the congenitally blind in the perception of weight differences, particularly with regard to lighter weight. Consequently, if the quantity of illusion is calculated using the results of Procedure A as the standard baseline, Procedures C and D appear to produce very little Charpentier illusion in the adventitiously blind.

<u>The Charpentier illusion and duration of blindness</u>. To examine the effect of duration of blindness on the perception of weight the subjects were divided into three groups.

Group 1 - over 10 years of blindness	13
Group 2 - 5 to 10 years of blindness	3
Group 3 - less than 5 years of blindness	5

The results tabulated on this basis are shown in Tables 17 and 18. It is unfortunate that the second and third groups were disproportionately small.

Contrary to our expectations, differences between the three groups have almost the same tendency as was shown by the groups classified on the basis of age at onset of blindness. There is some general similarity between the three groups; they are particularly close in Procedures C and D. The first group shows no time error under Procedures A and B. No subject in any of the three groups showed the Charpentier illusion in Procedure B.

Next, we selected three subjects from each extreme of the continuum. The three subjects in the group

Table 13

Procedure / Judg. / S	B-A h	B-A e	B-A l	C-A h	C-A e	C-A l	D-A h	D-A e	D-A l
Group I	-0.4	+0.3	+0.1	+5.5	-0.6	-4.9	+3.6	+0.3	-3.9
Group II	-1.4	+0.4	+1.0	+4.2	+0.1	-4.3	+2.5	0	-2.5

Table 14

Analysis of Variance According to Table

Source	Sum of Sq.	Df.	Mean Sq.	F_0
Diff. btw. procedure	2766.5	3	933.17	20.04
Diff. btw. cong. and acquired	371.5	1	371.50	8.06
error	138.0	3	46.00	--
Total	3275.0	7	--	--

Table 15

Procedure / Judg. / S	A h	A e	A l	B h	B e	B l	C h	C e	C l	D h	D e	D l
Group I	9.8	2.5	8.7	10.2	2.7	8.1	16.5	2.2	2.3	13.2	2.8	5.0
Group II	8.6	3.3	9.1	7.6	3.6	9.8	13.1	2.4	5.5	12.6	3.4	5.0
Group III	10.0	2.0	9.0	10.3	1.3	9.4	16.4	1.3	3.3	14.3	1.3	5.4
Group IV	12.8	2.8	5.4	9.7	4.3	7.0	14.7	3.8	2.5	13.5	3.5	4.0

Table 16

Procedure / Judg. / S	B-A h	B-A e	B-A l	C-A h	C-A e	C-A l	D-A h	D-A e	D-A l
Group I	+0.4	+0.2	-0.6	+6.7	-0.3	-6.4	+3.4	+0.3	-3.7
Group II	-1.0	+0.3	+0.7	+4.5	-0.9	-3.6	+4.0	+0.1	-4.1
Group III	+0.3	-0.7	+0.4	+6.4	-0.7	-5.7	+4.3	-0.7	-3.6
Group IV	-3.0	+1.5	+1.5	+1.9	+1.0	-2.9	+0.7	+0.7	-1.4

Table 17

Procedure / Judg. / S	A			B			C			D		
	h	e	l	h	e	l	h	e	l	h	e	l
Group I	9.2	2.8	9.0	8.8	3.1	9.1	14.5	2.4	4.1	12.8	3.1	5.1
Group II	9.7	3.0	8.3	10.6	3.7	6.7	17.0	1.3	2.7	14.3	2.3	4.4
Group III	12.2	2.2	6.6	9.6	2.4	9.0	15.2	3.0	2.8	13.6	2.6	4.8

Table 18

Procedure / Judg. / S	B-A			C-A			D-A		
	h	e	l	h	e	l	h	e	l
Group I	-0.4	+0.3	+0.1	+5.3	-0.4	-4.9	+3.6	+0.3	-3.9
Group II	+0.9	+0.7	-1.6	+7.3	-1.7	-5.9	+4.6	-0.7	-3.9
Group III	-2.6	+0.2	+2.4	+3.0	+0.8	-3.8	+1.4	+0.4	-1.8

Table 19

Procedure / Judg. / S	A			B			C			D		
	h	e	l	h	e	l	h	e	l	h	e	l
Group I	9.0	2.4	9.6	9.3	2.4	9.3	17.6	1.7	1.7	13.3	2.4	5.3
Group II	13.0	3.0	5.0	8.7	3.6	8.7	14.3	4.3	2.4	13.0	4.0	4.0

Table 20

Procedure / Judg. / S	B-A			C-A			D-A		
	h	e	l	h	e	l	h	e	l
Group I	+0.3	0	-0.3	+8.6	-0.7	-7.9	-4.3	0	-4.3
Group II	-4.3	+0.6	+3.7	+1.3	+1.3	-2.6	0	+1.0	-1.0

Table 21

Procedure / Judg. / S	A			B			C			D		
	h	e	l	h	e	l	h	e	l	h	e	l
T.K.	10	2	9	9	1	11	16	2	3	16	1	4
E.O.	15	5	1	2	7	12	11	9	1	11	8	2
N.S.	12	2	7	13	6	2	16	2	3	15	2	4

representing long duration of blindness had each been blind for 18 years. Those in the second group had been blind less than three years. In general, the same tendencies are observed for these two groups as in the ones examined in Tables 19 and 20. Under Procedure C the second group has a smaller Charpentier illusion effect than the first group. We suspect this may be the result of having less experience in tactile perception. They are probably less able to use this sense modality effectively than the subjects in Group 1, who have had 18 years of experience in the use of touch.

To examine more closely the relationship between age at onset of blindness, duration of blindness and the development of weight perception, we selected the following subjects as typical:

T, blinded at 13, present age 15, duration of blindness 2 years

E, blinded at 23, present age 25, duration of blindness 2 years

N, blinded at 19, present age 28, duration of blindness 9 years.

The data on weight perception of these subjects is summarized in Table 21. It is clear that there is a large difference between subjects T and E despite the fact that the duration of their blindness was the same. Subject T's judgments were more exact and stable than E's. E had many judgments of "same" and "not clear." We feel this is because subject T was blinded as early as the 13th year, while E did not become blind until the age of 23. Early loss of vision seems more important for the development of weight perception than duration of blindness. Subject N, a girl who was blinded at 19, has been blind for 9 years. In spite of this, her weight perception is neither exact nor stable. She was able to make only a few correct judgments regarding the lighter weights. Although the sample is too small, we suspect that whether blindness occurs before or after the age of about 13 makes a great difference to the development of compensatory sensitiveness in the other modalities. In comparison to the age of onset, the duration of blindness seems to be a less important factor.

IQ and the Charpentier illusion. In the opinion of C. Spearman[5] there is nearly a +1.00 correlation between general intelligence and sensory discrimination. Yet there are authors who do not accept this theory of the coincidence of these two capabilities. We wished therefore to test the relationship between IQ and the Charpentier illusion. The subjects were divided into three groups on the basis of intelligence assessment with the Ohwaki block design test. The average IQ for all subjects was 90, and the groups were constituted as follows:

Group 1 - below 70 . . . 6

Group 2 - 71 to 110. . . 7

Group 3 - over 110 . . . 7

The experimental results tabulated on the basis of this grouping are shown in Tables 22 and 23. Except for Procedure A there are few differences in weight judgments between the three groups. Statistical analysis of the results indicates no significant differences between the three groups (Table 24).

Let us then compare the subjects with the highest and lowest IQ. Subject I had an IQ of 136, had been blind for 13 years and was 13 years old. Subject II had an IQ of 51, had been blind for 11 years and was 14 years old. Tables 25 and 26 show their judgments and the differences between judgments for the various procedures, respectively. The judgment of Subject I shows little variance between procedures A and B, while Subject II shows a remarkable amount. Moreover judgments of "equal" are made frequently by Subject II but are rare with Subject I. The Charpentier illusion in Procedures C and D occurs very often in Subject I, less so in Subject II. In cases of such extreme differences in IQ, we can find remarkable differences in the discrimination of weight also. In such cases, therefore we can say that Spearman's theory is adequate.

Table 22

Procedure / Judg. / S	A h	A e	A l	B h	B e	B l	C h	C e	C l	D h	D e	D l
Group I	10.0	3.4	7.6	8.3	3.4	9.3	14.0	2.9	4.1	13.3	3.6	5.1
Group II	10.6	3.7	7.7	11.0	3.3	6.7	15.3	3.3	2.1	14.3	2.7	4.0
Group III	9.8	2.2	9.0	9.5	2.6	8.9	15.8	1.7	3.5	13.7	2.3	5.0

Table 23

Procedure / Judg. / S	B-A h	B-A e	B-A l	C-A h	C-A e	C-A l	D-A h	D-A e	D-A l
Group I	-0.2	0.0	+0.2	+5.6	-0.8	-48.0	+3.5	-0.2	-3.3
Group II	-0.5	+0.5	0.0	+4.1	-0.6	-3.5	+3.1	-0.5	-2.6
Group III	+0.3	0.0	-0.3	+6.9	-0.3	-6.6	+4.3	+0.6	-4.9

Table 24

Analysis of Variance According to Table 23

Source		Sum of Sq.	Df.	Mean Sq.	F_0
Diff. btw.	procedure	5237.6	3	1779.20	41.96
	IQ	9.9	2	4.95	0.12
	error	254.5	6	42.41	
	total	5502.0	11		

Table 25

Procedure / Judg. / S	A h	A e	A l	B h	B e	B l	C h	C e	C l	D h	D e	D l
Group I	9	1	11	9	2	10	19	0	2	17	0	4
Group II	8	4	9	5	6	10	11	1	9	12	3	6

Table 26

Procedure / Judg. / S	B-A h	B-A e	B-A l	C-A h	C-A e	C-A l	D-A h	D-A e	D-A l
Group I	0	+1	-1	+10	-1	-9	+8	-1	-7
Group II	-3	+2	+1	+3	-3	0	+4	-1	-3

Summary of Results of Experiment II

1. From the results of Experiment I we surmised that the blind were able to make discriminations of size without a direct tactual examination of the objects. By altering the apparatus to eliminate both subliminal auditory cues and subtle indirect muscular ones, occurrence of the Charpentier illusion was prevented. This result of Procedure B demonstrated that such cues had in fact been the basis for the size discrimination.

2. No statistically significant differences were found in the Charpentier illusion between congenitally and adventitiously blind subjects, but those who lost their vision at sixteen or later were clearly inferior in the discrimination of weight.

3. Age at onset of blindness was a more important factor for the perception of weight than the duration of blindness.

4. The relationship between level of intelligence and perception of weight was not statistically significant. However, when a very high IQ subject was compared with a very low IQ subject, remarkable differences in the ability to discriminate weight were found.

Since G. Th. Fechner, Charpentier and G. E. Muller,[6] much experimental research has been carried out on the Charpentier illusion of weight. As theories to explain the illusion, we cite Muller-Schumann's theory of muscular sensation of lifting speed, Seashore and Marbe's expecting image theory,[7] Friedlander's mental set theory,[8] and Usnadze's theory of visual perception of difference.[9] We believe that the visual perception of size difference is the strongest factor for the occurrence of the Charpentier illusion. Therefore Usnadze expected that the Charpentier illusion would not appear, in the sighted with eyes closed or in the blind. However, in the blind, the Charpentier illusion occurs if he perceives and knows the size difference of two objects through touch or muscular sensation of grasping. This phenomenon was observed already by J. F. Rice and A. Peiser. We too observed it in the first experiment (Procedure C). Far beyond that, without directly touching the large and small objects, the Charpentier illusion occurs in the blind (Procedure B). They *can* discriminate the size of two objects without directly touching them, by lifting them up successively, grasping only the handles of identical size.

Through the second experiment we have ascertained that this size discrimination is possible through the hearing of subliminal sounds and through faint muscular sensation of resistance. This is proven because if we so arrange the apparatus that these sensations do not occur, the Charpentier illusion does not appear. The normal cannot hear the sounds, much less the difference between them when he puts a 600 gr. box on a cushion. No audiometer can measure such loudness of sound. The blind are able to sense such subliminal stimuli and through them discriminate the volume of objects. Subliminal stimulation has recently attracted attention in America on the occasion of recent advertising demonstrations. J. V. McConnell et al. gave an excellent overview of previous experimental research on subliminal stimulation.[10] We think the blind and the deaf-mute feel such subliminal stimuli much more than the normal. Audition, touch, muscular sensation of the blind and vibration sensation of the deaf-mutes are very often the sensing of such subliminal stimuli.

On the other hand, perception of subliminal stimuli by the blind means a remarkable development of his sense organs. This proves the immeasurable potential development of our sense organ's sensibility, if trained properly and from a young age.

The blind, especially the congenitally blind are very accurate in discriminating up-lifted weights. In their comparisons there is almost no negative time error. Consequently the negative time error in successive comparison is not always a general phenomenon. In the sighted, whose comparison ability is not good, time error generally occurs. But in the congenitally blind, whose discriminating ability of weight is remarkably sharp, the time error does not occur. From these results we must conclude that the trace theory of negative time error of W. Kohler and K. Koffka is, though elaborate, not as generally adequate.[11]

The age at onset of blindness is a more important factor for the occurrence of the Charpentier illusion of weight than the duration of blindness. The group blinded at 16 years or later is especially very inferior in weight perception. These results suggest that the development of sensory-motor learning, especially learning of subliminal sensations is very slow in the 16 year old and older. The weight perception in the Charpentier illusion belongs to the so-called "early learning" of D. O. Hebb.[12] There seem to be age limitations on this sort of learning. According to the experimental results of Sonoko Ohwaki, the Charpentier illusion does not appear in three year olds (chronological age), but in the 4 to 5 year olds (mental age) the ability develops suddenly and remarkably.[13] This finding seems to correspond with our results.

In addition, our results seem to suggest that subliminal perception becomes possible when one is blinded before 10 years of age, so that he can discriminate weight differences almost as well as the congenitally blind, if the duration of blindness is not too short.

The relation between the level of intelligence and the quantity of Charpentier illusion is not statistically significant, if we compare the groups of different intelligence level as a group. However, if we select a subject of very superior IQ (136) and a subject of extremely low IQ (51), and compare their Charpentier illusions, we find a clear difference appearing in Procedures C and D. In weight comparison after tactile inspection of the two boxes the Charpentier illusion of the former is much larger than that of the latter (Procedure C). Again, in weight comparison after verbal information about the size difference, a difference in Charpentier illusion is observed between them. This difference suggests that the extreme difference of intelligence level influences subliminal sensation.

SUMMARY

Even the blind who have no visual sensation show the Charpentier illusion in the successive comparison of two weights, if they perceive and know beforehand the size difference between the two objects through touch and muscular sensation. This fact was found by J. F. Rice and A. Peiser. We have found it in the first experiment (Procedure C). Moreover, without directly grasping or touching the two boxes, many blind persons show the Charpentier illusion. We found this in first Procedure B. Through the observation of subject's behavior and verbal reports of his introspections, we were able to hypothesize the sensory basis for it. It seemed possible for him to perceive the size difference through the difference in faint muscular sensation when the object was put down on a cushion, and by hearing sounds imperceptible to the sighted.

To ascertain whether this was in fact true, we improved the experimental apparatus and arrangements. New subjects were used in this second experiment. The results of this experiment show that as we expected under the second Procedure B, which eliminated these cues, the Charpentier illusion does not occur.

In the congenitally blind, almost no negative time error appears when he compares successively two weights in boxes of the same volume. The adventitiously blind, on the contrary, show the negative time error. This indicates that the weight perception of almost all of the congenitally blind are very exact. It also suggests that Kohler and Koffka's "field theory of trace" is not adequate.

DISCUSSION

No statistically significant relationship was found between age at onset of blindness and the

Charpentier illusion. However, the adventitiously blind who lost their vision at the age of sixteen or later were remarkably inexact in weight perception, particularly in the case of lighter weights, while the congenitally blind gave very correct judgments.

Duration of blindness, unless extremely short, did not have as strong an influence on the Charpentier illusion as the age at onset.

The relationship between IQ and the Charpentier illusion was not significant statistically. However, comparing two subjects selected to represent the two extremes for the group (IQ 136 and 51 respectively), a remarkable difference was found, although their ages and duration of blindness were similar. The low IQ subject showed only a slight Charpentier illusion when allowed to examine the boxes tactually, (Procedure C), nor did he show as much Charpentier illusion as the high IQ subject when informed verbally of the difference in box sizes.

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THE SPATIAL SENSE OF THE BLIND: A PLAN FOR RESEARCH

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INTRODUCTION

A comprehensive study of the ability structure of the blind, conducted at the Institute of Occupational Health (IOH), has revealed that the blind present the same average level in the several mental abilities as the seeing; and that the ability structure of the blind is as differentiated as that of the seeing.[1]

The problems with which the blind must cope are associated mainly with mastery of the external physical world. Thus, research aimed toward aiding the blind in this mastery might proceed along two courses. First, efforts might be made to discover how the mobility of the blind could be improved with various technical mobility aids. Second, an attempt might be made to discover how spatial relationships are, or can be mastered on the basis of other sense data than that of vision without technical aids. The first approach is of great practical importance, and is followed at present in numerous studies. The second approach is potentially of the utmost theoretical and practical importance, but so far has attracted attention only rarely.

The building of spatial impressions on the basis of sense data other than that of vision has been so greatly neglected that it has influenced some choice of problems even in psychology. In the analysis of the structure of intelligence for example, attention has been focused almost exclusively on a single aspect of spatial ability, namely, the so-called visual-spatial or visualization ability. This has been analyzed extensively, and its relationship with a variety of other mental abilities has been explored (e.g., numerical, reasoning, and verbal abilities), but no attempts have been made to discover how it is related to mental manipulation in space on the basis of modalities other than the visual.

The lack of interest has been due, no doubt, to the fact that vision invariably has been supposed to furnish a frame of reference for any kind of spatial functioning. The "transposition theory" also has its roots in this mode of thinking. This theory asserts that whenever operations involving spatial relationships based on senses other than vision are called for, these operations are accomplished by transposing the sensations or images peculiar to the modality into visual images, then by carrying out tasks by ideation within, so to speak, the field of the sense of vision. This way of conceiving of the problem has led some investigators to maintain that the congenitally blind do not have any genuine spatial ability. And the adventitiously blinded are therefore supposed to rely on whatever remnants of their visual imagery or ideation they can in the solution of problems in spatiality.

The results of our rather extensive research project at IOH during the period of 1963 through 1965 convinced us that views similar to the transpositional theory are essentially erroneous (Juurmaa 1965, 1967a; Juurmaa & Suonio 1969). This same research led to the two problems to be discussed here. Let us state our views in brief.

First, all the operations involving spatial patterning and relationship in the central nervous system (CNS) seem to be independent, in principle, of the sensory input modality concerned. By the phrase "in principle" I mean that there is a tendency for any set of sensations to organize into spatial patterns irrespective of the modality. But the strategies employed in the CNS differ, however, from one modality to another. Hence the question: How long does it take to learn a spatial strategy adequate to a sense modality which is not ordinarily employed in spatial operations? And, further, how are the particular modality-specific spatial abilities related to one another and to other ability traits? Neither of these questions have been investigated; either among the blind or the sighted.

Second, if one believes that independent spatial appreciation is possible on the basis of data from any sense modality, then it is implied that the transposition theory must be modified. It is obvious, first of all, that the concept of transposition is problematic in itself, and does not provide a key to the solution of the possibility of nonvisual spatial abilities. In short, the term has been used to describe a rather ill-defined complex of phenomena; a painstaking theoretical and experimental analysis of this complex would be necessary to discover the roles they actually play in spatial performance.

The plan of research is oriented around answers to the two problems sketched above. Success in its execution can be expected to provide us with an essentially new picture of the processes by which our concepts of space come into being. But the implications of the research are not only theoretical, as important as that result may be. The implications for the negotiation of the newly blinded through the period of adjustment of reduced or no visual input are enormous, and the implications of the research for occupational choice in the rehabilitation process are equally great.

In the assessment of the capabilities of the newly blinded, for example, it would be important to know how the several modality-specific spatial aptitudes of the individual compare with average levels for these aptitudes; and thus to infer what modalities are likely to offer him the best substitute for vision. Experiments oriented toward the interrelationship of the modality-specific aptitudes would yield information relevant to this assessment. We would also expect to learn something about the time period required to learn spatial strategies peculiar to the other senses; and the possible dependence of spatial performance on other psychic functions. Data of this kind are very important in planning training courses in form perception, which do not exist at the present time. Our experiments in "projective transposition," to be outlined below, may yield results directly applicable to the rehabilitation of blind persons, for they may well provide us with means by which the process of learning of a new environment could be speeded. We will also learn what part visual imagery actually plays in this process.

In guiding occupational choice in general rehabilitation schemes, we have found that the results of our prior research permitted the construction of an ability test-battery which is now used at the IOH. The battery could be improved still further by better knowledge of the development of the spatial sense. In guiding sighted persons into suitable occupations, much attention is paid to their visualization ability. It is natural to ask whether, in the case of blind persons, spatial abilities appropriately assessed can play a similar role. It is possible that the predictive powers of the spatial ability test might be comparable to the predictive power of the visualization test for the seeing. We do not plan to explore this question of validity *in extenso*, but the question cannot be dealt with at all unless one has enough information about the general structure of spatial ability.

Beyond these three implications, there is the interesting question of cortical localization and its implication for the study of brain injury. Given an adequate knowledge of the way in which spatial ability is interrelated in normal persons and in sensorily deprived persons, findings from the performance of the brain injured could be employed to estimate the location of trauma. We do not yet have the appropriate knowledge of interrelationship of spatial ability. As Hans-Lukas Teuber (Semmes et al. 1955) writes:

"The question of modality-specificity has both theoretical and practical significance. On the theoretical side, further elucidation of the nature of these defects (brain injuries), and ultimately how the nervous system mediates spatial functions, presupposes knowledge of the degree of independence of modalities in such perceptual organization. On the practical side, it is important as a guide to rehabilitative procedure to know if the patient can profit by information about the spatial aspects of the environment conveyed by a sensory route other than vision."

A study of the interrelationship of various spatial abilities can serve as a frame of reference, therefore, for corresponding studies of the brain injured.

PRINCIPAL STUDY AIMS

There are three aims of the research, each oriented around a specific problem area. The first is oriented to the question: To what extent are the abilities for mental manipulations in space on the basis of various sense modalities intercorrelated? The second area is concerned with the question of transposition. The third area is concerned with the intercorrelations among spatial ability, transposition, and some control variables. Let us discuss each of these in turn.

The Intercorrelations Between the Abilities for Mental Manipulation In Space Among the Various Sense Modalities

Let us assume that a number of spatial tests can be presented to a group of individuals, tests analogous to visualization tests. To what extent will performance on such tests correlate? Or, to put it differently, is it legitimate to speak of a "general spatial ability," in the sense that a person who does well on tactually perceived spatial problems can also be expected to do well on spatial tasks involving the mastery of extensive kinesthetic locomotion patterns? Or will we discover only particular modality-specific spatial abilities that are relatively independent of each other?

The existence of a number of particular spatial abilities, corresponding to vision, touch, kinesthetic-proprioceptive sense associated with parts of the body, that sense associated with mastery of locomotion patterns, audition, and the vestibular sense, will be hypothesized. We shall then examine the interrelation of these several abilities in congenitally blind, adventitiously blind, and seeing individuals.

Should the several spatial abilities correlate, then obviously they must have a common basis in the CNS, directly or indirectly. If they do not correlate, or if there are uncorrelated groups of intercorrelated particular spatial abilities, new problems will arise, for correlational independence may be due to one or more factors of the following kinds:

1. Interindividual differences in the relative degree of development of various "compartments" of the CNS or, more specifically, the cerebral cortex;
2. Interindividual differences in practice and training in the use of strategies adequate to the several senses;
3. Interindividual differences in sensory discrimination;
4. Interindividual differences in transposition facility.

Factors in Groups 2 and 3 are related to the questions raised above regarding modality specific spatial ability, and to the third area of interest already mentioned.

Should no other explanation arise for the independence of the various spatial abilities, then factors like those in Group 1 are operative, although we do not propose to explore this further. Note, however, that there are some relevancies here between this study and the study of the brain injured.

Our particular attention would be devoted to factors like those in Group 2, namely in differences in training and practices in strategies appropriate to the several senses. We shall make an attempt to form groups of seeing persons as homogeneous as possible regarding the amount of training they may have had in utilizing spatial strategies in the senses other than vision. We shall be interested also in how the various modality-specific spatial abilities may change as a function of the duration of blindness.

Three studies already completed bear on this set of problems, and were completed at the IOH (Juurmaa 1965, 1967a, 1967b). One investigated ability structure and loss of vision. Another dealt with the orientation ability of the blind, where we focused on interrelations among spatial performance based on vision, touch, and kinesthetic sense. In both cases, the performance of the blind and the seeing were compared. In a third study, spatial performance based on vision, on touch, and on motor-auditory sensation was compared using a group of sighted persons.

The major results of these studies bearing on the present issue follow.

First, for the blind, tactual-spatial ability, and the ability to master locomotion patterns, formed a single factor.

Second, in the case of the congenitally blind, the performance on tactual tests structurally analogous to some well-known tests of visual ability formed a factor on their own, independent of both reasoning and dexterity. The result is theoretically interesting, since the possibility of employing visual imagery or ideation was totally excluded. Two further questions arise concerning this result: are there ability traits with which the factor thus obtained is correlated? and, can this factor be identified with the visual-spatial factor of the sighted?

Third, the results suggest that if the performance of a blind person on tactual-spatial tasks and the accuracy of his hearing are known, his success in learning to master a new environment can be predicted with a considerable degree of reliability. A knowledge of the duration of blindness and the hearing ability makes it possible to predict performance in obstacle perception and avoidance.

Fourth, our results using sighted persons suggest that there is a number of independent modality-specific spatial abilities: visual-spatial ability, tactual-spatial ability, the mastery of spatial kinesthetic locomotion patterns, and spatial performance based on successive auditory patterns--each comprised a separate factor.

It should be underscored that all of the above are preliminary results in need of further confirmation. They were obtained in studies not specifically designed for exploration of the issues raised in the present research plan. Subject groups were heterogeneous; the same group of persons was not used in studies to explore the interrelations of all the factors obtained; and, finally, no purely auditory-spatial tasks were included. Even if further experiments confirm the finding that the several spatial abilities are not interrelated among the seeing in the same way as they are among the blind, we should still have to answer the question of why these abilities behave differently among the seeing and the blind.

The Problem of Transposition

This area is directed not so much at a problem as at a problem group. In general, three kinds of questions are considered. We want to know, first, how far people *attempt* to replace sensations or images peculiar to a specific sense modality by images peculiar to another sense modality; second, how far they are likely to *succeed* in such attempts; and, third, how far such replacement *helps* in performing a specific task.

Up until now, most investigators have been interested exclusively in how far visual imagery and ideation is helpful in accomplishing spatial tasks based on the sense of touch. The performances of the congenitally blind, the adventitiously blind, and the sighted have been compared on this basis (Juurmaa 1965, 1967a).

Worchel's view, that visual images are helpful in such tasks, is quite generally accepted, for the seeing do better than the visually impaired and the congenitally blind do least well. I have tried to show, however, that what has been involved in experiments of this kind is "associative recognition" rather than "transposition proper"; the figures employed have been "optically familiar" (Juurmaa & Suonio 1969). Our preliminary experiments suggest, in fact, that when the figures involved are not "optically familiar" to subjects, visual imagery and ideation are of no help to them. It is also doubtful whether attempts at transposition are even made in such situations. It is obvious that further experiments are necessary to confirm or deny this assumption. In any case, as I have already pointed out, the term "transposition" is used to cover a multitude of psychic functions. One should make at least the following distinctions:

First, "associative recognition." A pattern familiar to a person from his experience within a particular sense modality sphere is recognized associatively when it makes its appearance in the sense data received through another sensory route. What is involved in this case, usually, is recognition of "optically familiar" patterns through the sense of touch. By "optically familiar" patterns I mean simple regular figures such as squares, triangles, or other forms that have occurred often in that person's experience.

Second, "transplantation." An individual may make an observation of a concrete pattern in one sense and try to "shift" it concretely to another sense department. For example, he may view a square or triangle and attempt to select tactually one of a number of figures in which the spatial relationships are the same as in the visual model. Concrete sensations, rather than perceptual images, are involved in both sense departments.

Third, projection. A pattern perceived with one sense is projected ideationally and, by changing the scale, entered onto the field of another sense department. This is particularly important in the case of the blind, for it is important that a blind person can transpose a tactually perceived pattern projectively into an extensive locomotion pattern, and vice versa.

Fourth, translation. When an individual has had no prior experience, in any sense modality, with a spatial pattern of relationship he is required to manipulate, he may attempt to translate them into a familiar-sense modality and to work with these. If a person attempts to determine tactually the shape of a figure not familiar to him as an optical shape, he may attempt to translate his tactual sensations into visual images and to operate on it in that modality. As we see it, "associative" transposition has often been confounded with what we have called "translation."

We intend to design experiments to explore all four types of transposition, and to find out several consequences in various pairs of sense departments. Among the questions we hope to answer would be: is transposition possible (in principle) in one direction and in the other? If it is possible in both directions, is it practiced or attempted in only one direction, or in both? If attempts at transposition are made in both directions, are these more frequent in one direction than in the other? Is transposition helpful? Is it harmful? And, finally, does its helpfulness or harmfulness depend on the direction of transposition?

Answers to these questions concerning the frequency of occurrence of various types of transposition and their possible helpfulness or harmfulness depend, among other things, on the manner of reception of sensory material. When a spatial pattern is presented to an individual, he may be an active observer or a passive recipient;

furthermore, the pattern presentation may be simultaneous or successive.

These remarks may suffice to indicate that the matter of "transposition" is highly complex; it should occasion no surprise that we do not propose to "solve" the problem exhaustively. Thus, we do not intend to devise experiments to cover every possible combination of the component elements outlined above. Our choice of problem, and our construction of experiments, depends partly on their practical significance, partly on the base of data that we have built already which offers us a starting point for further investigation. For example, "projective transposition" is of particular significance for the blind, and our studies to date have given us some insight into their use of this transposition. Other variables will be included in our experiments: among them are intelligence and sensory discrimination variables studied by prior authors (Juurmaa 1965).

Interrelationships of Major Factors

We mention here a third group of problems and projected aims which we will make observations about, but on which we will conduct no specific experiments; in mentioning them, we wish to underscore our continuing sensitivity to the implications of our experiments in wider contexts. In any event, the experiments we are conducting will offer us the opportunity to consider the interrelationship among spatiality, transposition, and control variables. We plan to use the same group of individuals as subjects for these as for our basic experiments.

The most interesting question here is on which spatial factors do the various transposition and discrimination variables obtain their loading. An analysis of just this kind will make possible the formation of an increasingly accurate picture of the process of interaction between the various senses that forms a basis for spatial function associated with one or another sense modality. For example, suppose that we know an individual's tactual/spatial ability. Does this enable us to predict his ability for projective transposition in the tactual/locomotor direction? Since this is a field which is, to date, not mapped at all, only such basic experimentation can reveal what kinds of transformational variables are useful in differential psychological description, accounting for the individual differences we observe in the persons around us.

As another example of this kind of analysis, we might ask how do discrimination variables such as auditory or tactual accuracy correlate with the various tactual and/or transposition performances? The results we have obtained so far suggest that both the discrimination variables associated with the sense of touch and those associated with hearing correlate, in the case of the blind, with tactual/spatial and locomotor/spatial abilities. And, again, do discrimination variables have the same influence on the performance of the sighted as on the performance of the blind?

Experimental Techniques

Our study consists in the conduct of experiments with blind and with sighted individuals, and in the statistical analysis of the results of our experiments. I shall touch but briefly on the approach involved.

Development of tests. Spatial tests must be developed for each sense modality except that of vision. Test methods for experiments on tactual/spatial and kinesthetic/spatial abilities have already been devised at the IOH. Our methods developed for use with the sense of touch still correlate too strongly with operational facility in near space and with dexterity/ and we still strive to improve these methods so we can end with a way of measuring spatial performance alone. Our experiments on kinesthetic performance have provided us with an adequate reference system for constructing a series of tasks of uniformly increasing item difficulty. Differential psychological test methods for purely auditory/spatial performance have not yet been developed, either at IOH or elsewhere, to our knowledge. One method we plan to use is a "buzzing cube" constructed of a frame of wood laths sides measuring six by six meters, and divided into 27 smaller cubic frames of sides of two by two meters. At each of the points where laths cross, a buzzer will be located. Buzzers will then be sounded to "trace" a three-dimensional "auditory curve," and the subject will be required to recognize the curve by identification of its equivalent from among a number of tactual or visual alternatives.

Experimental Arrangement. For the group of problems which are concerned with the interrelations of various spatial abilities, we plan individual test experiments. For the second group of problems we have outlined above, those concerning transposition, we shall use a variety of experimental arrangements. For example, subjects will be required to reproduce in one sense modality the figure presented to him in another sense modality, and we shall employ cross-modal form discrimination and cross-modal transfer of learning tasks. Active observation and passive reception will both be employed, as will simultaneous and successive exposure.

Statistical Analysis. In the first phase, we will use correlation techniques mainly, with their elaborations, i.e., factor-analytic and other multi-variate methods. Similar methods seem appropriate for the comparative study of spatial ability, transposition, and discrimination variables. In the middle group of experiments, dealing with transposition, we shall emphasize comparisons between means, particularly the analysis of variance.[2]

NOTES

1. It directly follows that a blind person's ability to get along in life will depend decisively on his mobility skill and spatial mastery. Only scant attention has been given to this important point in the literature, but it has been confirmed also empirically in a few studies, most clearly in Graham & Robinson (1968), where an almost linear relationship was found between an individual's mobility skill and his capacity to earn an independent livelihood. Yet the capacity to earn a living is but one aspect, for a blind person's mobility and mastery of spatial relationships also largely determine the extent to which he can lead a rich and full life in general, by participating in politics, recreation, study, leisure activities, etc., and they are among the chief determiners of his self-confidence.

2. Funds have not been available in Finland for the execution of such an extensive research project as the one outlined here. A comprehensive theoretical analysis of the transposition phenomena, written by the author, will be published this year.

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AN ATTEMPT TO TEST THE PERSONALITY OF THE BLIND USING THE MMPI*

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INTRODUCTION

The significance of both an emotional and a social adjustment is underlined in many articles dealing with the rehabilitation of the blind. The achievement of this adjustment is one of the aims of rehabilitation and a fundamental condition for bringing the blind back into society. The basis for psychotherapy, which could be described as a social rehabilitation of the blind, is a strict clinical assessment of maladjustment, in other words a diagnosis of personality. Those diagnostic tests which could supply information about the personality of the blind without, at the same time, creating difficulties during the actual testing are of great importance. These conditions are met by personality inventories. The most suitable of the several available inventories appears to be the MMPI (Minnesota Multi-phasic Personality Inventory).

The existence of a Polish adaptation of this inventory, as well as Z. Pluzek's paper dealing with its application and containing test results of a sizeable sample of Polish test subjects made us choose this inventory.

TESTING PROCEDURE

The adjustment of the MMPI to suit the needs of testing the blind involved, above all, a change in testing procedure. The usual application of this inventory necessitates the subject's independent perusal of items printed on cards. The blind, of course, cannot do this and the use of Braille was impossible because not all of the subjects could read it fluently. Therefore the items were read aloud to the subjects.

Four persons were tested at a time. The group method was used in order to provide the subjects with an intimacy and anonymity which, at first sight, seems paradoxical. It was assumed that testing each blind subject individually might influence the frankness of the replies, and more so than in a group test, might create an impression that the test was something like a personal confession which not all of the subjects might wish to do.

Only diagnostic items, those which are part of the various clinical and control scales, were asked. The experimental items were omitted. Also omitted was the M-F (masculinity-femininity) scale since research conducted on the Polish sample revealed that this scale has little diagnostic value because of a dissimilarity of social cultures. The blind subjects, therefore, answered only 342 items. The Polish version of the MMPI (WISKAD) contains 550 items.

When sighted people are tested, the order of the items is purely haphazard. If when testing the blind, the items were read in the same order consistently it might affect their replies in some way. This in turn might affect the scores in the various scales, or at least introduce an added factor which would complicate any comparison between the scores of the blind and the sighted. We tried to eliminate

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Table 1

Comparison of Mean T Scores of Blind and Sighted Subjects on MMPI

		?	L	F	K	Hp	D	Hy	Ps	MK	Pa	Pt	Sc	Ma	It
Blind	Mean	30	53,7 51,9	73,4 72,1	45,7	60,1 56,1	66,5	56,8 53,6	59,4	--	68,6	65,0 64,6	73,1 73,1	59,2	56,5
N = 30	S.D.		10,46 9,77	10,37 10,22	6,06	10,90 10,87	11,70	9,22 8,75	13,12	--	11,06	16,19 16,03	17,77 17,75	7,57	12,09
Sighted	Mean	50,9	55,6	60,7	53,7	52,5	64,8	57,4	58,0	--	55,5	57,0	59,7	51,4	55,7
N = 100	S.D.	3,07	9,08	7,60	7,03	10,11	12,69	9,39	10,16	--	8,23	11,08	10,33	10,03	7,85
$\bar{z}$			0,68 0,94	5,87 5,90	6,06	3,37 15,93	0,67	0,31 2,03	0,53	--	5,88	2,50 2,39	3,87 3,87	4,53	0,33
Probability Value			N.S. N.S.	0,01 0,01	0,01	0,05 N.S.	N.S.	N.S.	N.S.	--	0,01	0,05 0,05	0,01 0,01	0,01	N.S.
Standard Error of Difference			2,80 2,03	2,06 2,05	13,26	2,26 2,26	2,52	1,95 1,87	2,64	--	2,21	3,20 3,17	3,46 3,46	1,72	2,38

The figures underlined indicate the scores of blind subjects computed with exclusion of eight items "loaded."

this factor by reading the items in a different order to each four-person group.

This change of procedure was not the only difficulty which had to be overcome when using the MMPI with the blind. Some of the diagnostic items refer to visual efficiency or to situations where eyesight plays an important part. These items assumed that the subjects' functioning of the senses was normal. The meaning of such items when testing the blind is obviously going to be different than the authors of the inventory had intended. Validity of such items are doubtful.

These items belong to the following scales:

L - 1 item (J_{41})

Pt - 1 item (G_{41})

F - 3 items (H_{21}, H_{27}, H_{24})

Hy - 3 items (G_{40}, A_{31}, A_{32})

Hp - 2 items (A_{31}, A_{32})

Sc - 1 item (H_{27})

RESULTS

The calculation of the raw scores in the scales, which include these items, and their conversion into standardized T scores was carried out twice. The first calculation took into account the real replies of the subjects and treated them according to the norms of the test. The second treated the replies as if all the subjects had answered "cannot say."

Thirty blind males undergoing a one-year rehabilitation course at the Chorzow Centre of Rehabilitation of the Blind were tested. All can be described as blind people who are either not rehabilitated or only beginning rehabilitation. The conclusions reached should not, therefore, be applied to all blind people, but only to those who are maladjusted.

The group was so chosen that half of it consisted of subjects with a greater than 20/200 loss of vision and half with smaller than 20/200 loss of vision.

The mean scores of the two 15-member groups were compared with each other in all the scales. Application of student's T test revealed that the differences between the two groups were statistically insignificant in all the scales. For analytical purposes, therefore, the 30-member group was treated as a whole.

Z. Pluzek's "The Value of the MMPI for Differential Diagnosis in the Field of Psychiatric Nosology" contains the scores of a group of 100 males with normal sight. This sample consisted of men who were assessed also as normal in other respects, i.e. they did not display any symptoms of mental disturbance nor had they undergone psychiatric treatment. The scores of thirty blind men were compared with those of this group. The statistical significance of the differences between the two groups was measured by calculating the critical ratio of the mean T scores in the various scales of the two groups to the standard error of the difference ($\bar{z}$). The similarity of the two groups' chronological age and educational level made this statistical calculation feasible. All the data used to illustrate the scores of people with normal vision in the MMPI are taken from Pluzek's paper.

Table 1 shows the mean T scores, the standard deviation, the standard error of the differences between the mean T scores and $\bar{z}$, which indicates the statistical significance of the differences between the means of the two groups in the various scales of the MMPI.

Statistically significant differences between blind and sighted men occurred in two control keys (F and K) and in four clinical scales.

The configuration of the control scales is significantly different from the norm. The high score in the F scale reveals personality difficulties, unconventionalism and atypical modes of reaction to social situations. The higher Sc scale next to the high F proves that the blind make use of schizoid and paranoidal defense mechanisms more often than the sighted. They also have a greater tendency to avoid people and a more difficult and selective contact with their environment. The percentage distributions of the scores of the two groups in F scale are compared in Table 2. There was not one blind person with a low score, i.e. less than 50 T. The blind had border scores (71-90 T) far more frequently than the sighted; 56.7 percent of the blind and only 12 percent of the sighted. This confirms the conclusions suggested by comparison of the arithmetical means.

The scores of K scale are low; they differ from the norm to an extent which is statistically significant. They reveal weak defense mechanisms, a lack of self-acceptance, a feeling of inferiority and a pessimistic disposition, as well as a narrow range of interests and a tendency to brood on personal failures. These are not transitory moods; they are permanent personality traits. Interesting is the very small standard deviation which shows only a very slight dispersion of the scores in this scale. The percentage distribution of scores of the two groups is given in Table 3. The blind had scores which were either low or medium; nobody had more than 65 T in K scale.

In L scale the mean score of the blind is somewhat lower than that of the sighted, but the difference is not statistically significant. Nevertheless, a comparison of the dispersion of the scores (Table 4) shows that the blind achieve either very low scores (less than 41 T) or low scores (41-45 T) more frequently than the sighted; and medium scores (45-65 T) less frequently. It can be claimed, therefore, that the blind are more prone to a tendency to admit small faults, offenses, and failures. This could be to draw attention to themselves and secure their environment's help. One can suppose that, compared with their blindness, these small faults either do not appear to be important or seem to be totally justified in the blind man's situation.

Nearly all the blind had scores of less than 50 T in "?" scale. Only 3 of them had a score more than 50 T.

The blind reveal a tendency rather to aggravate existing symptoms than to dissimulate them. They try to give the impression that they are more maladjusted and require more help than is in fact the case. They exaggerate their difficulties and regard their situation as very frustrating. In this respect they are clearly different than the sighted (Table 5). None of the subject's had Gough's index (the F-K dissimulation index) showing tendency to conceal difficulties. A quite significant percentage of the blind had Gough's index revealing a tendency to aggravate indicating that blind people with weakened defense mechanisms who are emotionally immature (far more frequent than among the sighted) have a great need of acceptance.

There is a difference in the configuration of the clinical profiles between the blind and the sighted (Table 1 and Figure 1). In the scales which belong to the psychotic triad (Pa, Sc, Ma) there were statistically significant differences at a level of 0.01; 0.05 in the Pt scale, regardless of how one treats the eight items "loaded with error." The statistically significant difference in the Hp scale is lost after elimination of the eight items, and in the Hy scale the difference comes near to the level of 0.05. Hysteria is also the only scale among the clinical scales in which the blind had lower scores than the sighted. This would appear to be an important fact, for in these two scales (Hp and Hy) most of the items dealing with the functioning of the sense of sight appear, and consequently are loaded with error when testing the blind. If someone with normal vision answers items A_{31} and A_{32} ("My vision is as good as always," "I can read a lot without suffering eye-strain") in the negative, he thereby reveals hypochondriac traits and a use of a hysterical conversion mechanism. If the same items are put to blind people the meaning of the replies will, of course, be quite different. That is why exclusion of these items eliminates the statistically significant differences between the blind and the sighted in the Hp scale. This demonstrates a sound understanding of the items by the subjects and confirms the validity of the test when applied to the blind.

Why do the blind achieve lower scores in the Hysteria scale than

Table 2 and all the following tables give the scores of the blind excluding the eight items arbitrarily judged to be "loaded with error" when testing the blind.

Table 2

Mean T Scores on the F Scale for Blind and Sighted Subjects

T score	Blind %	Sighted %
41 - 50	-	6.0
51 - 70	43.3	82.0
71 - 90	56.7	12.0
91 - 110	-	-

Table 3

Mean T Scores on the K Scale for Blind and Sighted Subjects

T score	Blind %	Sighted %
30 - 45	50.0	6.0
46 - 65	50.0	86.0
66 - 80	-	8.0

Table 4

Mean T Scores on the L Scale for Blind and Sighted Subjects

T score	Blind %	Sighted %
41 or less	13.3	-
41 - 45	20.0	4.0
46 - 65	53.3	82.0
66 - 85	13.3	14.0

Table 5

The F-K Dissimulation Index for Blind and Sighted Subjects

	Dissimulation		Simulation		
	-11	-12	+9	+10	+11
Blind	-	-	-	13.3%	3.3%
Sighted	30.0%	21.0%	2.0%	1.0%	-

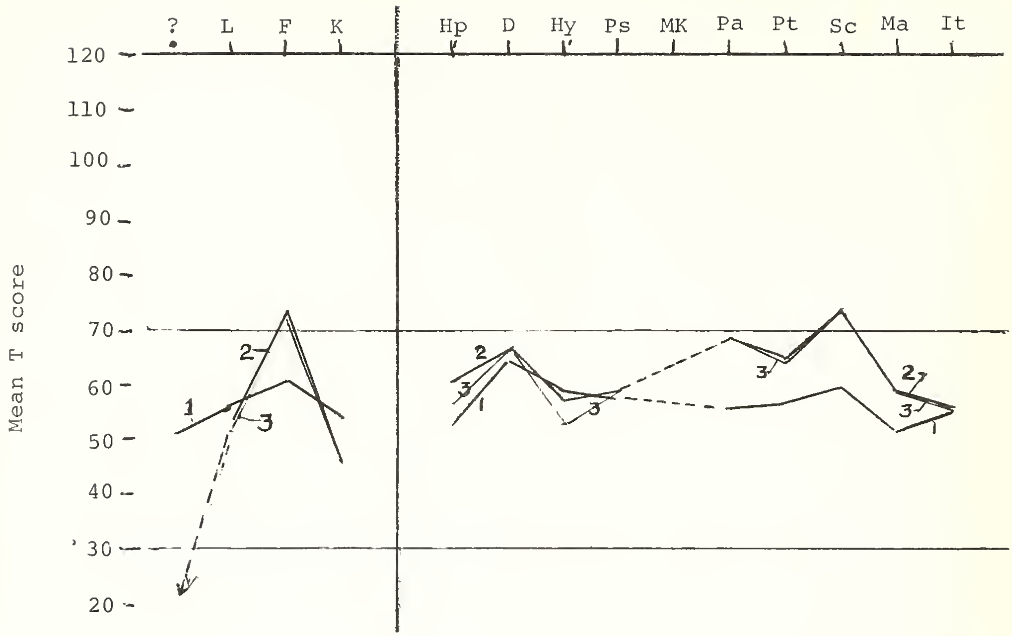

Figure 1. Mean T Scores of the Blind (N = 30) and the Sighted (N = 100) in MMPI

1 - profile of the sighted males

2 - profile of the blind males (without exclusion of eight items "loaded")

3 - profile of the blind males (with exclusion of eight items "loaded")

the sighted, while their whole profile suggests a worse emotional adjustment? It seems that they do not need to resort to conversion as a means of resolving their difficulties and conflicts. The very fact that they have lost their sight is enough to justify their failures. They do not need to look for other somatic defects which would absolve them of responsibility for their errors and explain their lesser independence and lower status, which creates a feeling of inferiority revealed by the other scales. This hypothesis, however, goes beyond the data of our experiment and requires confirmation.

The lack of any statistically significant difference in the third scale of the neurotic triad (Depression) is surprising. This could, however, be a result of an overstatement of this scale in Z. Pluzek's investigation p. 78, ". . . One should take into account the possibility of an overstatement in the scores of the Depression scale . . . among males. . . ," in the sample of Polish population.

Differences which were somewhat higher than the level of 0.05 were obtained in Pt scale. This confirms the suppositions made on the basis of the low K-scale scores and indicates a more frequent occurrence among the blind of feelings of guilt and inferiority, a great reserve in interpersonal relations, anxiety and phobias. The large standard deviation in the Pt scale, however, shows a significant dispersion of scores, which corresponds to wide individual differences among the subjects.

The statistically significant differences in all the scales of the psychotic triad (Pa, Sc, Ma) allow one to regard the blind as an isolated group with a strong feeling of social alienation. The small standard deviation occurs in the Pa scale; the high mean T score (68.6) comes close to the pathological borderline. This allows one to conclude that there are very many among the blind who reveal symptoms such as suspiciousness, a rigidity of outlook and opinion, narrow interests, a lack of emotional ties with their environment, with a simultaneous high sensitivity to reprimands and criticism--in short they reveal traits of a paranoid personality.

Another indication of the fact that the blind are an isolated group in which the prevailing pattern of adjustment is one of avoidance and isolation is the high score in the Sc scale (mean - 73.1). However, the large dispersion of the scores (between 30 T and 109 T) shows that this need not be the only method of adjustment open to the blind, and the loss of sight itself is not the deciding cause for its choice.

The high scores in the Ma scale of the blind group indicate the presence of unstability, excitability, and a tendency towards emotional accumulation.

The blind more frequently reveal border profiles (43.3%) or medium profiles (33.3%); increasing (46.7%); single-phase (33.3%) or hillock-shaped (33.3%). The percentage distribution of the heights of the shapes and the incline of the profiles is markedly different than that of the sighted group (Table 6).

The percentage distribution of the codes, taking into account the two highest scales of the profiles, is shown in Table 7 for the blind and Table 8 for the sighted.

Scales 6 and 8 (Pa and Sc) are the most frequently dominating in the profiles of the blind. The most frequent codes are 78, 68, and 26.

The percentage of one type of code is not perhaps high enough to allow talking of a characteristic profile of a blind person, but it does allow one to claim that among blind subjects more often than among sighted subjects (Table 8), the MMPI detects paranoid personality traits (Pa scale) and the whole blind group shows symptoms of alienation and weak ties with its environment (Sc scale).

CONCLUSIONS

The MMPI is useful for testing the blind after the introduction of a few changes which concern the

Table 6

The Incline (Skewness) of the Profiles for Blind and Sighted Subjects

	Decreasing %	Neutral %	Increasing %
Blind	10.0	20.0	46.7
Sighted	10.0	34.0	11.0

Table 7

Percentage Distribution of Codes for the Blind
(Z. Pluzek)

Scale	Hp 1	D 2	Hy 3	Ps 4	Pa 6	Pt 7	Sc 8	Ma 9
Hp 1	--	6,7	--	--	--	--	--	--
D 2			3,3	3,3	10,0	3,3	3,3	--
Hy 3				--	--	--	--	--
Ps 4					--	--	6,7	6,3
Pa 6						3,3	20,0	6,7
Pt 7							23,3	--
Sc 8								6,7

Table 8

Percentage Distribution of Codes for the Sighted
(Z. Pluzek)

Scale	Hp 1	D 2	Hy 3	Ps 4	Pa 6	Pt 7	Sc 8	Ma 9
Hp 1		7	--	--	1	--	--	--
D 2			9	13	5	12	10	3
Hy 3				1	--	--	3	2
Ps 4					3	1	6	4
Pa 6						1	4	4
Pt 7							3	2
Sc 8								3

actual testing procedure and the interpretation of the answers to some of the items.

The method of interpretation applied here, elimination of the eight items in which sight plays an important part, is the simplest way to avoid difficulties. Although this method caused only an insignificant drop of the scores in a few scales, these items should be replaced if the test is to be used more widely. The scale containing the new items should be validated by testing a large sample of blind people. There would then be a valuable technique for diagnosing the personality of the blind.

The mean personality profile of blind males indicates that their emotional adjustment is not as good as the sighted. The dispersion of the scores, however, is too large to allow us to speak of a typical personality profile of the blind. It can be claimed, nevertheless, that cases of people with weakened defense mechanisms and with a tendency to exaggerate personality difficulties are more frequent among the blind than among the sighted. The predominating adjustment depends on withdrawal from people and adoption of a distrustful and suspicious attitude. There was also a marked isolation and social alienation of the blind which is, perhaps, strengthened by the setting up of separate places of work, residential schools and other social care institutions for them.

The cross-section data obtained do not trace the dynamics of the formation of the personality traits observed. It is difficult to specify to what extent these traits arose as a result of loss of sight; as it is difficult to assess if loss of vision or the blind man's social situation is the more important factor here. The small number of subjects limits the possibility of looking for an interdependence of emotional adjustment with such factors as individual personality traits (prior to the loss of vision), the etiology of blindness, the age at which blindness occurred, the time of duration of the handicap, the family situation and so on. It would seem that in investigating the differences between the blind and the sighted one can leave aside hereditary factors, i.e. assume that these factors influenced both groups in the same way. The majority of those tested lost their sight as a result of illness or an accident. There is no reason to suppose that illnesses and accidents which lead to the loss of sight occur more frequently among those with hereditary predispositions.

The lack of differences in the mean scores between the totally and the partially blind indicates that the degree of loss of vision does not influence emotional adjustment significantly. It is likely that any possible differences are cancelled out by the almost identical social situations of the totally and the partially blind; both groups are separated from people with normal vision to a similar extent. It can be assumed that the characteristic pattern of behavior is, to some extent, imposed on the blind by social stereotyping. Only a very few can resist this stereotyping. It can be claimed, however, that with all certainty, loss of vision itself does not unequivocally determine personality traits, nor does it fix the level of adjustment of the blind.

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THE ROLE OF VISUAL AFFERENTATION IN FORMING THE ELECTRICAL ACTIVITY OF THE CORTEX OF THE HUMAN BRAIN

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Editor's Note: The following is a translation of Chapter 9 of L. A. Novikova's *The Influence of Impairment of Vision and Hearing on the Functional Condition of the Brain*, Moscow: Prosvieshchenie, 1966. A translation of the entire work will be published shortly by the American Foundation for the Blind under the title *Blindness and the Electrical Activity of the Brain: Electroencepholographic Studies of the Effects of Sensory Impairment*.

What is the role played by various afferent systems in forming human cortical rhythms? It has been established that without the flow of visual afference alpha-rhythm is not formed. A statistically significant correlation was found between visual acuity and the degree of saliency of alpha-rhythm. The comparison of the EEGs of blind and deaf children has shown with the greatest clarity the significance of visual afferentation in generating the basic rhythm of the human EEG—alpha-rhythm. As has been demonstrated alpha-rhythm, which is not present during blindness, is not broken off with the loss of auditory afferentation. In addition alpha-rhythm in deaf-mute people is not only preserved, but sometimes becomes even stronger.

These facts, as well as the direct relationship between the degree of saliency of alpha-rhythm and visual acuity, serve as a convincing proof that visual afferentation has a decisive role in the formation of alpha-rhythm.

The investigations have not only disclosed the role of visual afferentation in generating alpha-rhythm, but also enabled us to reach some conclusions about its generative mechanisms. As has been shown, alpha-rhythm may persist for several weeks after the cessation of the flow of visual afferentation. After several months of blindness the alpha-rhythm begins to decline and the EEG acquires a character typical of the blind: absence of alpha-rhythm, lowering of the amplitude of electrical oscillations, predominant depression of the cortical rhythm in the occipital area of the cortex, and displacement of the focus of maximal electrical activity to the central areas of the brain. Alpha-rhythm was not discovered in a single case of congenital blindness; but if total blindness took place late, single alpha-oscillations were preserved on the EEG.

These observations point to the importance of the trace (Sledovye) processes in forming the focus of the alpha-rhythm. Evidently the focus of the alpha-rhythm can be preserved for a certain time after the interruption of the flow of visual afferentation, it can arise on its traces. At the same time the trace processes can, be it for a time, secure the conditions necessary for the formation of alpha-rhythm. The more time that has elapsed from the moment of the loss of sight, the more the traces of alpha-rhythm become effaced.

During the analysis of the EEG of the blind and visually impaired, the following fact has attracted attention. It was disclosed that alpha-rhythm decays in total sight loss as well as when the light perception is preserved. Only with a visual acuity of 0.01 to 0.04 does alpha-rhythm begin to register in a significant number of cases (about 40 percent). So that the appearance

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of alpha rhythm coincides with the increase of visual acuity to the point where one is able to distinguish the shape of objects. Therefore, in order to have alpha-rhythm, one must have enough vision to perceive objects and shapes. In other words the alpha-rhythm appears on the human EEG only when the photic stimulations acquire the significance of a signal for the central nervous system.

Similar formulations can be found in the paper by Cohen, Boshes and Snider (1961). The conclusion resulting from their investigations, that the flow of visual afferentation has a decisive significance in forming alpha-rhythm, would seem to be in conflict with the widely known fact that there is better saliency of the alpha-rhythm in darkness and with the subjects' eyes closed. It would be entirely wrong, however, to draw an analogy between the closing of one's eyes and total and prolonged interruption of the flow of visual afferentation. First, while the eyes are closed, the afferentation continues to flow from the optic organ toward the central nervous system because the activity of part of the receptors in the retina is not only preserved in darkness but becomes even stronger (Granit, 1957).

Second, as was reported, the alpha-rhythm does not decay immediately after the onset of blindness. Most likely, the exclusion of a powerful flow of visual afferentation causes metabolic changes in the nervous tissue which develop over a length of time and which are the cause of the decay of alpha-rhythm on the EEG of a blind person.

During research on the mechanism of the formation of the alpha-rhythm a question arises: what is the role of the cortex and subcortex in this process? The problem of localization of the focus of alpha-rhythm and of the presence of one or more generators of alpha-activity has been discussed in the literature since the first electrophysiologic investigations. Adrian and Jamagiwa (1935) suggested that there may be two independent generators of alpha-rhythm in each of the hemispheres. A similar opinion is found in Eccles' paper (1953).

Corbin and Buckfordin (1955) applied an analyzer to research on the EEG and described a periodic asymmetry of alpha-rhythm in the hemispheres; according to them this is proof that two independent foci of alpha-activity exist in each hemisphere. These observations were confirmed by Walsh (1957, 1958) who used the method of cross-correlation. Placing a chain of electrodes in the occipitoparietal leads, he discovered in each hemisphere two independent foci of alpha-rhythm, not coinciding in phases. Cooper and Mundy-Castle (1960) came to the same conclusion on the basis of their research on cortical rhythms using the toposcope.

Cohn (1948), using the method of superimposition, described four independent foci of alpha-rhythm in the occipital area of each hemisphere. Walter (1950) also suggested the presence of a number of alpha-rhythm foci in the occipital areas of each hemisphere.

Theories advocating the presence of numerous foci of the alpha-rhythm in the occipital area of the cortex have been confirmed in the last few years by electrophysiologic research conducted by means of the electrodes inserted in the cortex of the human brain. Sem Jacobsen, et al. (1955-1956) and later Perez-Borja, Chatrian, and Rivers (1962) discovered in the mass of the occipital area of the cortex a multitude of alpha-rhythm foci, distinguished by the different frequencies of their oscillations. Better saliency of the alpha-rhythm in the superficial layers of the cortex indicates, according to Sem Jacobsen, its cortical nature.

Cooper and Mundy-Castle (1960), in order to explain independent foci of the alpha-rhythm arising in the cortex of both hemispheres, introduced the concept of a domain. These authors believe that at the basis of the synchronization of the cortical neurons lies the strengthened interaction between the neurons organizing the participation designated by this term. The arising of independent foci of synchronistic activity in the cortex of the brain is explained by the increase of mutual influences between the cells, which facilitates the creation of the domain. In order to support this hypothesis, one can avail oneself of the morphologic observations of Sholl (1953, 1955), who discovered the greatest density of dendritic plexuses in the occipital area of the cortex. Similar opinions are offered by Cragg and Temperley (1954) who suppose that the ferromagnetic properties of the neurons are the basis of the formation of the domain, producing the foci of alpha-rhythm are in the occipital areas of the cortex in each hemisphere.

The opposite point of view is held by Aird and Garoutte (1958), Garoutte and Aird (1958), Garoutte, Aird and Correnti (1958), Garoutte, Aird and Ogden (1956), who investigated twenty-four adults and found synchronization of the alpha-rhythm between the hemispheres in a significant number of cases. In the later study Garoutte and Aird (1958), while investigating the degree of synchronization of alpha-rhythm by alignment of the peaks of alpha-waves in 52 subjects, found a total synchronization of the alpha-oscillations in 50 percent of the cases. Since in certain cases of damage to the corpus callosum an interhemispheric synchronization of the alpha-rhythm is seen, the authors hypothesized the existence of a subcortical pacemaker organizing and controlling the subcortical rhythms. According to their view the pacemaker, common to both hemispheres and securing an interhemispheric synchronization of the alpha-rhythm, is located in the hypothalamus or in the reticular formation of the midbrain (in structures connected with both hemispheres).

Hill and Driver (1962), however, point out correctly that the synchronization of the alpha-rhythm is found in only half of the cases and that it could be related to the similarity of the neuronal organization of the cortex of both hemispheres.

Thus, one can see in the literature two points of view with regard to the mechanism forming alpha-rhythm. According to one group of authors (Adrian, 1944; Cohn, 1948; Walter, 1950; Eccles, 1953; Corbin and Buckford, 1955; Walsh, 1957-1958; Sem Jacobsen et al., 1956; Cooper and Mundy-Castle, 1960; Perez-Borja, Chatrain and Rivers, 1962) several independent foci of the alpha-rhythm are formed in the cortex itself. Other authors suppose that there exists a subcortical pacemaker that secures the interhemispheric synchronization of the rhythms (Aird and Garoutte, 1958; Garoutte, Aird and Ogden, 1956 and Barlow, 1960).

Facts obtained during research on the blind and visually impaired prove the role played by visual afferentation in forming the alpha-rhythm, but they do not indicate where it arises. Certain deductions with regard to the formation of the focus of alpha-rhythm could be made on the basis of research on homonymous hemianopia. During homonymous hemianopia a sharp asymmetry in the degree of saliency of the alpha-rhythm in the hemispheres was seen. These observations are in full agreement with data from a number of papers (Case, 1940; Engel, Ferris and Romano, 1945; Blinkov and Rusinov, 1949; Pampiglione, 1952; Tron and Pressman, 1955; Bergman, 1957; Drechsler and Hladka, 1954).

The sharp asymmetry of the alpha-rhythm under homonymous hemianopia could, it seems to us, indicate that independent foci of alpha-rhythm are formed in both hemispheres. Particularly convincing are the cases of tract hemianopia. If, as Aird and Garoutte suppose, a pacemaker of alpha-rhythm were placed in the reticular formation of the midbrain, then, considering the bihemispheric connections of those structures, the asymmetry of alpha-rhythm during homonymous hemianopia, would be minimally expressed. A subcortical pacemaker in the reticular formation of the midbrain or hypothalamus, being charged by the flow of preserved visual afferentation, should generate alpha-rhythm in both hemispheres.

One should point out, however, that the fact of the asymmetry of alpha-rhythm under homonymous hemianopia testifies only against the existence of a subcortical pacemaker located in the structures of the reticular formation of the stem, common to both hemispheres. The question of what is the significance of the specific and nonspecific structures of the thalamus which exert predominantly ipsolateral influences on the cortex, remains unexplained.

The first formulation of the importance of thalamocortical circuit of excitations in forming the alpha-rhythm belongs to Dusser de Barenne (1937). His ideas were further developed in several works (Beritov, 1943; Roitbak, 1955; Gastaut, 1949).

The contribution of Okuta, et al. (1954) deserves special mention. They discovered better alpha-rhythm saliency in the nuclei of the thalamus in comparison with the cortex of the human brain.

Barlow (1960) draws attention to the similarity of alpha-rhythm to the discharges that are the aftereffects of afferent stimulations ("sensory afterdischarge"). Since the after-effect discharges are connected with the nonspecific afferent system, their similarity to alpha-rhythms could also be connected with the reticular formation of the thalamus. It is evident that to study the role of subcortical structures in the formation of the occipital focus of alpha-rhythm, research on the human EEG by means of implanted electrodes should be considered of decisive importance.

In the papers mentioned, the authors brought out facts concerning the formation of the occipital focus of alpha-rhythm, but there arises a problem. Is the alpha-rhythm limited to the occipital area of the cortex, or do the independent foci of alpha-activity exist in other areas of the cortex? Case (1942) presupposed the existence of three independent foci of alpha-rhythm in the brain spreading to the occipital, parietal, and frontal areas of the cortex. Marsland, Austin, and Grant (1949) observed alpha-rhythm still in the temporal area of the cortex in three out of six patients after a total onesided removal of the occipital part of the brain. On these grounds they made a deduction that the preserved parts of the hemisphere were capable of producing the alpha-rhythm. All the authors, however, do not exclude the possibility that the alpha-rhythm spread from the intact hemisphere. Maiorchik and Federova (1949) recorded the alpha-rhythm in the frontal area of the cortex in schizophrenics after lobotomy.

When considering those facts one must strictly differentiate between the two questions: the possibility of synchronized, sinusoidal oscillations arising with another functional significance than alpha-rhythm and the problem that alpha-rhythm may be formed in the occipital areas of the brain and spread into other areas of the cortex. Gastaut discovered rolandic rhythm, which in many outward respects resembles alpha-rhythm, but has a different functional importance. As Gastaut and a number of other authors have shown, rolandic rhythm registers predominantly in the central areas of the cortex, it may have an arc-like shape, but sometimes has a sinusoidal character whose shape does not differ from alpha-rhythm. In its frequency and amplitude characteristics it is also close to alpha-rhythm. However, rolandic rhythm, unlike alpha-rhythm, is connected not with the visual but with the kinesthetic analyzer. A proof of this--besides the localization of rolandic rhythm in the cortical end of the kinesthetic analyzer--is the fact of its great sensitivity to proprioceptive and tactile stimulations.

As it has been shown, rolandic rhythm is more pronounced on the EEG of the blind than that of sighted persons; which once more underlines its independence of the flow of visual afferentation. Thus, in the central areas of the cortex of the human brain there are recorded rhythmical, sinusoidal oscillations similar to alpha-rhythm but of a different origin, and therefore correctly isolated by Gastaut as an independent focus of the rolandic rhythm.

During our research on the EEGs of blind persons during sleep we have discovered another type of sinusoidal oscillations differing in several ways from alpha-rhythm. These oscillations, appearing in the drowsy state or during sleep, are unlike alpha-rhythm in that they are predominant not in the occipital, but in central, and frontal areas of the cortex. They differ from alpha-rhythm by the variability of their frequencies, which depending on the depth of sleep, varies from 6 to 14 cps. The same type of alpha-like oscillations are described in the papers of Brazier (1949), and F. Gibbs and E. Gibbs (1950).

Analyzing the EEGs of sighted and blind persons during drowsiness and sleep can convince one that there exists a genetic unity of these sinusoidal oscillations with theta-rhythms, with bilateral bursts, and with spindles of sleep. On a number of tracings one could observe mutual transitions from one type of these oscillations to the other. From time to time the sinusoidal oscillations looked like the spindles spread over a longer period of time.

Thus, there are several foci of synchronized, sinusoidal oscillations of different functional importance and different origin in the human brain:

1. alpha-rhythm, localized in the occipital area of the cortex and formed under the influence of the flow of visual afferentation;

2. rolandic rhythm, registering in the central areas of the cortex and determined by the flow of proprioceptive afferentation;

3. synchronized, sinusoidal oscillations, appearing on the EEG during sleep, predominantly in central and frontal areas. These oscillations are evidently connected with the subcortical structures of the brain that take part in the development of inhibitions in the sleeping state.

Since in blind persons the occipital focus of the alpha-rhythm is absent, the independence of rolandic rhythm and the sinusoidal oscillations arising during sleep from the occipital alpha-rhythm becomes even more evident.

It follows that when analyzing an EEG it is imperative to proceed from the functional characteristics of the rhythms registered on the EEG and their connection with the afferent systems. In order to classify the types of oscillations appearing on the EEG it is not sufficient to rely on any single indication. For instance, the alpha-rhythm, the rolandic rhythm, and the synchronized oscillations of subcortical origin may coincide in frequency; the subcortical, alpha-like oscillations registered during sleep, as well as the rolandic rhythm, are predominantly located in the central areas of the cortex; and the rolandic rhythm, just like the alpha-rhythm may have a sinusoidal character. Only by taking into account the aggregate of all indications characterizing various rhythms--their spread over the cortex, frequency, shape, and above all, connection with the afferent system--can one correctly classify the various oscillations found on the EEG.

The question of classifying the oscillations on the EEG according to functional, and not external, morpholobic indications, goes beyond the framework of terminologic arguments. In the literature of encephalography it often happens that any oscillations found on the EEG within the frequency range of 8 to 13 cps are classified as alpha-rhythm. How erroneous such a purely formal external approach to the analysis of cortical rhythms is may be easily demonstrated in the EEG of children. Oscillations of a frequency of from 10 to 12 cps registering on the EEGs of infants are often called alpha-rhythm. As the brain matures, these oscillations become gradually more frequent and reach the frequency of beta-rhythms. Besides, the rhythmic oscillations localized in the occipital areas of the brain in children under three years of age do not usually exceed a frequency of 5 to 7 cps. The fact that these oscillations are localized in the occipital area of the cortex and become depressed during photic stimulations, is precisely why they should be regarded as resembling alpha-rhythm. As the brain develops, the frequency of these oscillations increases and reaches that of alpha-rhythm in adults.

Therefore, from all that has been said before we conclude that one should not designate as alpha-rhythm any given rhythmical oscillations or sinusoidal character and a frequency of 8 to 13 cps, that are found on human EEG, but only those localized in the occipital area of the cortex and caused by the flow of visual afferentation.

As was demonstrated, the EEG of the blind is characterized--apart from the absence of alpha rhythm--by a general lowering of the voltage of all electrical oscillations. In the blind person, the drop in the amplitude of the electrical oscillations is most predominant in the occipital area of the cortex. However, the depression of cortical rhythms spreads to other parts of the brain as well. That is why the generalized changes in the cortical rhythms of the blind cannot be explained by the phenomena of a secondary transneuronal degeneration. According to the observations of Leonowa (1896), Berger (1900), Kononova (1926), Henschen (1926), Pines and Prigonnikova (1936), and Pines (1948), certain atrophic and degenerative changes take place in the fourth and fifth layer of the cortex of blind people. However, those structural changes are limited to the occipital area and do not spread over other sections of the cortex. If the disturbances in the cortical rhythms of blind people depended upon transneuronal degeneration, they would be limited to the occipital area.

What then is the cause of the general lowering of the amplitude of the electrical oscillation in all areas of the cortex, so characteristic of the EEG of the blind? In the literature on the subject we often find the opinion that the depressive character of the EEG of the blind and the disappearance of alpha-rhythm are caused by a continuous state of tension, as if it were an inextinguishable orienting reaction which exists in people deprived of sight (Berger, 1936; Loomis, Harvey, and Hobart, 1936; Stepanov, 1955; Zimkina, 1956; Asafov, Zimkina, and Stepanov, 1955). Our research on the EEG of the blind during the arousal and extinction of orienting reactions brought us to the conclusion that this point of view is erroneous. As has been shown, the orienting reactions in the blind are extinguished as quickly as those in sighted people. After full extinction of the orienting reaction, alpha-rhythm does not appear on the EEG of the blind and one does not observe any increase in the voltage of the electrical oscillations.

The dynamics of changes in the cortical rhythms in relation to the time elapsed since the loss of vision are of particular interest in order to appreciate the functional importance of the depressive character of the EEG of blind persons. If the depression of cortical rhythms were caused by the tenseness and alertness of people deprived of sight, then, of course, it would have a maximum expression during the first days or weeks after the loss of vision. In the first weeks after the onset of blindness alpha-rhythm may persist and the depression of cortical rhythms is still insignificant. As the duration of blindness increases, the alpha-rhythm decays more and more and the degree of depression deepens; at the same time one may observe a shift of the focus of maximal electrical activity toward the central area of the cortex and the formation of rolandic rhythm.

Certain cases of blindness and of deaf-blindness we have been investigating over the course of several years were particularly convincing. In those cases the depression of the electrical potentials of the cortex deepened gradually.

Our research on the EEG under homonymous hemianopia also justifies the hypothesis that the disappearance of alpha-rhythm and the character of the EEG are connected with the interruption of the flow of visual afferentation, and are not caused by the tense condition of the subject. This is proved by the fact that alpha-rhythm decays only in the de-afferented hemisphere and is preserved in the intact one. The arousal reaction as we know is always of a bilateral character.

In order to resolve the moot point, what the functional significance is of the depressive character of the EEG of blind people, we regard as important the frequency-characteristics of the traces. According to the numerous papers of such authors as Magoun, Moruzzi, Lindsley and several others, the arousal and watchfulness reactions are expressed in the majority of cases by the appearance on EEG of low amplitude but fast oscillations (Moruzzi and Magoun, 1949; Lindsley, Bowden and Magoun, 1949; French, von Amerongen and Magoun, 1952; Magoun, 1959; Rossi and Zanchetti, 1960). On the contrary, the depressed traces with slow cortical rhythms were repeatedly described as indicating the development of inhibiting conditions in the central nervous system, and of the lowering of the level of metabolism in cortical tissue. Such markedly flattened types of traces were observed during natural sleep (Blake and Gerard, 1937) as well as under narcosis (Beccher and McDonough, 1938; Denny-Brown, Swan and Foley, 1947; Failla, 1958; Seager, 1958).

A lowering of the level of metabolism of the central nervous system was discovered during the winter hibernation of animals. This is also accompanied by a reduction of the voltage and a decrease in the frequency of the oscillations constituting the EEG (Gerard and Liebert, 1938; Lyman and Mattfield, 1953).

Flattening and lowering of the cortical rhythms were repeatedly described during myxedema, the main symptom of which is the lowering of the level of basal metabolism (Ross and Schwab, 1939; Browning, Atkins and Weiner, 1954; Lansing and Trunnell, 1963).

The several EEGs of the blind quoted show that the drop in the amplitude of the electrical oscillations goes together with an impoverishment of the traces in fast potentials. As was demonstrated, markedly flattened traces were recorded in 39 percent of those cases where the loss of vision was complete.

The enumerated investigations enable us to reach the conclusion that the specific character of the cortical rhythms of the blind cannot be explained by the continuously tense condition of the subjects, and, therefore, cannot be related to increased activation of the cortex. The depressed character of the cortical rhythms of the blind evidently reflects, not the arousal reaction but, on the contrary, it is connected with a lowering of the cortical tone resulting from the exclusion of the powerful flow of visual afferentation.

This hypothesis, important in order to characterize the functional condition of the central nervous system of the blind, is in agreement with some data in the literature. According to the calculations of Bruesch and Arcy (1942), people receive about 40 percent of all the sensory flow through the fibers of the optic nerve. Therefore, the exclusion of such a powerful source of afferentation can produce a lowering of the cortical tonus.

The influence of light is especially evident in the development of the gonads, of secondary sexual characteristics, and in the reproduction of birds and mammals (Bissonette, 1932, 1936; Benoit, 1934, 1935; Clark, McKeoun and Zuchermans, 1939; Hill and Parkers, 1933; Marshall and Bowden, 1934; Rowan, 1938; Svetozarov and Shtraikh, 1940; Jefferson, 1940; Voitkevich, 1944, 1945; Karapetian, 1961). Bissonette (1936) artificially elicited heat in polecats by means of light, during the winter months. Voitkevich described the increase in size of the sexual glands of a squirrel under the influence of artificially amplified light. Many authors observe that the gonadotropic action of light depends upon the length of exposure not its intensity. (Bissonette, 1936; Voitkevich, 1948).

Keeping the animals in the dark, removing their eyes, cutting their optic nerves--all leads to a lowering of sexual activity and a decreased size of the gonads (Benoit, 1934, 1964; Hill and Parker, 1933; Bissonette, 1936; Voitkevich, 1945; Novikov and Favorova, 1947).

According to many authors, the influence of light on the activity of the sexual glands is by means of the hypothalamus and hypophysis

(Hill and Parkers, 1933; Scharer, 1937; Rowan, 1938; Voitkevich, 1944, 1945; Novikov and Favoroya, 1947; Markelov, 1948; and others). After the removal of the hypophysis, the light no longer exerts its gonadotropic stimulation. The basophilic apparatus of the anterior lobe of the hypophysis is extremely sensitive to light, and when there is none the number of basophilic cells decreases and the thyrotropic function of the hypophysis is damaged.

On the basis of these facts several researchers formulated a hypothesis about the existence of opticovegetative or photoenergetical system by means of which the light acts on the brain through the eyes. According to this hypothesis, the eye performs a double function: discriminative and analytic on one side, and photovegetative on another. The light-energy, directed into the hypothalamus and hypophysis, regulates the vegetative-endocrinal functions of the organism and exerts a generally tonic influence on the central nervous system.

The anatomic pathways through which the photoenergizing energy of light is able to exert its action, are described in the papers of Gudden (1874); Rossi, Mosinger (1934); Collin (1935); Frey (1947), 1950); Scharer (1937); Clark (1942); Dollander (1947); Novokhatskii (1956); Knoche (1957); Polyak (1957); Gergen and McLean (1964); Marg (1964). These authors discovered bundles of fibers, directed from the chiasm toward the various nuclei of the tuber cinereum, to the supraoptical nucleus of the hypothalamus, and to the pocket of the third ventricle.

Clark (1942), Renzi et al. (1959), Hayhow, Webb and Jervie (1960), described the fibers, branching off from the optic tract and directed to a group of cells, located in the roof of the midbrain.

Jefferson (1940), unlike many authors is of the opinion that activation of the brain by light does not have any special pathways and is accomplished through all the fibers of the optic tract.

Electrophysiologic research has shown the existence of extensive collaterals to the visual pathways to the various structures of the brain-stem. The papers of H. Gastaut and Hunter (1950), French, von Amerongen and Magoun (1952), Fillenz (1953), Johnson (1952), Hunter and Ingvar (1955) report that during photic stimulations there is an irradiation of the evoked potentials in the reticular nuclei of the stem of the thalamus, hypocampus, and other subcortical structures.

Massopust and Diagle (1961) discovered during photic stimulations evoked potentials and adoption of rhythm in the hypothalamus which confirms, according to them, the existence of opticodiencephalic pathways.

The hypothesis suggesting the existence of a photoenergetic system has been confirmed by numerous clinical investigations. The ophthalmologists, for instance, described the opticodiencephalic syndrome, with congenital damage to the retina accompanied by diencephalic pathology, retinitis pigmentosa, hemoralapia, and the Laurence-Moon-Biedl syndrome (Jeekens, Scottie, Handelman, 1947; Landay, Bromberg, Schorr, 1949; Francois, Stefens and deRouck, 1954; Streifler and Landay, 1955; Hoffman, 1956; Francois and deRouck, 1958; Krill and Stamps, 1959; Bardelli and Vedovini, 1961). During these illnesses, together with the pigmentary degeneration of the retina, one notices sexual gland insufficiency, obesity, a number of vegetative disorders, and sometimes mental retardation. Examination of the EEGs reveals theta-rhythm and bilateral bursts of slow waves pointing to damage to the brainstem in the area of the third ventricle (Markelov, 1948; Krill and Stamps, 1960; Lesny and others, 1961; Streifler and Landay, 1955; Bardelli and Vedovini, 1961).

Markelov (1948 and 1949), who ascribes great importance to the opticovegetative system and the vital activity of the organism, conducted a series of investigations of the photoenergetic action of light. He has demonstrated in his laboratory that intensified lighting causes a higher pulse rate, increase in the sugar content of the blood, speed-up in the production of antibodies, and stronger allergic reactions. Placing animals in the dark or covering their eyes produces opposite effects (Markelov, 1948, 1949; Mosketi, 1949; Boyevskaya, 1949; Israelson, 1949; Rutgaizer, 1949; Gaske, 1949). On the basis of this research Markelov reached the conclusion that photic impulses activate metabolism and their lack causes a displacement toward anabolism. The pulsation of vegetative functions during wakefulness and sleep is, according to Markelov, also connected with oscillations in the flow of visual afferentation since light, being a powerful regulator of vegetative functions, defines the daily periodic activity of the central nervous system.

The influence of the flow of visual afferentation on the function of the sympathetic nervous system was demonstrated in the paper of Sheveleva, et al., (1964). These authors have shown that after enucleation the development of cholinergic transmission of impulses in the synapses of the sympathetic ganglions of rabbits is delayed.

The tonifying influence of light on the cortex of the large hemispheres was demonstrated in a series of investigations on higher nervous activity. The papers of Denisov and Kupalov (1933) and Kupalov (1952) describe the drop in the magnitude of the conditioned reflexes in dogs placed in a darkened chamber. Rozenthal (1940) demonstrated that blinding dogs leads to a lower level of conditioned movement reflexes. Lobanova (1954, 1956) observed a short-duration lowering of conditioned and even unconditioned reflexes in dogs after they had been blinded. In the animals with a weak-type nervous system, the lowering of conditioned-reflex activity in the brain lasted for many months. Shepeleva's (1955) work showed that the temporary exclusion of sight in dogs is accompanied by a sharp decrease in the conditioned reflexes as well as in the development of hypnotic inhibition.

The tonic influence of light on locomotor activity was demonstrated in the paper of Arshavsky et al., (1948). The authors described how when puppies begin to see, there is a leap-like heightening of lability in the skeletal muscles.

According to the observations of Volkhov and Davidova (1954), at the moment the little rabbit begins to see, one observes on the EEG a leap-like increase in the voltage of the oscillations.

The importance of the flow of visual afferentation for the support of the cortical tone and the formation of the cortical rhythms was demonstrated in several investigations conducted in the early stages of ontogenesis (Farber, 1964, 1965; Kozodoi and Farber, 1965).

This research has shown an increase in amplitude, displacement of the frequency spectrum of oscillations on the background EEG of the rabbit, and increase in the frequency of discharges from the cortical neurons, from the moment the animal gains sight. Also shown is the formation of the primary rhythmic activity of the cerebral cortex in newly born animals and humans under the influence of photic stimuli.

Important observations, testifying to the tonic action of light on the central nervous system are contained in the papers of Chang (1952, 1962). According to Chang, prolonged exposure of the retina to light strengthens cortical response because of stimulation of the geniculate body. He observed the phenomenon of potentializing the potentials evoked during stimulation of the retina that was almost nonexistent during the stimulation of an auditory receptor. According to the author this emphasizes the significance of the flow of visual afferentation in maintaining the optimum level of cortical alertness.

Therefore, the combination of data: anatomic, biologic, and physiologic offers indisputable proof of the tonic action of light on the central nervous system, and shows the importance of the flow of light impulses in regulating the vegetative function of the organism. The facts support the ideas we have been developing with regard to the functional nature of the depressed character of the EEGs of the blind. It is evident that the exclusion of the powerful flow of visual afferentation leads to depotentialization of the cortex, which is reflected in the depressed character of the EEG.

For the time being the literature does not offer any unified point of view about the nature of the total electrical activity of the brain. According to the majority of authors, the EEG as a whole is connected with the dendritic potentials (Beritov, 1937, 1949; Roitbak, 1955; Clare and Bishop, 1952; Chang, 1951, 1952, 1955; Tasaki, Polley and Orrego, 1954; Purpura, 1963; Caspers, 1959; Okudzhava, 1963). Fewer authors agree with Adrian's earlier theory about the cellular nature of slow oscillations on the EEG. Although the nature of the rhythmical activity of the brain is not sufficiently clear, we can assume that the EEG reflects the condition of relative calm in the neural elements of the cortex, and not their excitation when working. However, the conditions of relative calm and activity are in a close physiologic interaction.

Ukhtomskii made a number of important statements about the connection between the level of relative "calm" and the activity of the organs and tissues: "We had reasons to point out that what we call 'a physiological state of rest' of the organs and the organism is not a self-explained condition of inactivity, resulting from 'an absence of impulses,' but represents a particular form of active reaction presupposing a high degree of organization in the physiological substrata and, partly, in the nervous system. In connection with this, an exceptional interest should be attached to the circumstances we have just mentioned and which was observed by Berger: that the most regular and uninterrupted rhythm of electrical discharges of the cortex, in particular the periods of alpha with its high amplitudes, is obtained in the state of physiological rest, i.e. in the absence of impulses from the receptory organs. The regular, almost harmonious rhythm of the cortical discharges appears as if it were a background, on which are being marked the current signals from the receptors." (Ukhtomskii, A. A., *An Outline of the Physiology of the Nervous System.* Vol. III, IV, L., 1945, p. 111.)

Thus Ukhtomskii not only demonstrates that alpha-rhythm reflects the condition of relative rest, but also emphasizes the deep physiologic connection between the condition of relative rest and of active behavior.

Based upon what was said one can suppose that even though the EEG reflects only the condition of "relative calm" and not of the working arousal of the brain, the changes in it represent important indicators of neurodynamic shifts in the central nervous system. That is why the depressed character of the EEG of the blind indicates the existence of neurodynamic shifts taking place in the central nervous system of people who are deprived of visual afferentation.

In the vast literature devoted to the study of the psychophysiology of the blind one can find a number of indications pointing to the lowered tone of their central nervous system, and at the impairment of their motor as well as certain vegetative functions connected with the changes of the hypothalamo-hypophysial system. Clare (1941) and Hollwich (1949, 1952, 1964) observed a lowering of the carbohydrate metabolism and water-balance in blind adults. Wassner (1954) obtained similar results when studying blind children.

Hollwich explained the disturbance in the water-balance of the blind by noting double function of the supraoptical nucleus of the hypothalamus, which acts both as an accumulator of photic impulses and a regulator of water-balance. In Hollwich's opinion, disturbance of the water-balance in the blind results from malfunction of this nucleus, when deprived of the flow of photic impulses.

Jendralski (1951) described a patient affected with diabetes insipidus who recovered after removal of cataracts.

Based on x-ray studies of the skull, Hollwich (1952) and Wassner (1954) reached a conclusion that in blind people the sella turcica is reduced in size, particularly in those people who had lost their sight early in life. According to Wassner's data, a significant decrease in size was observed in sixteen out of seventeen blind children.

No less important are the facts concerning the impairment of the motor sphere of the blind. For instance, several authors describe a syndrome of violent movements in blind and deaf-blind children (Makensen, 1956; Muller, 1957, 1959).

Muller formulates a correct proposition that the violent movements, which in sighted people indicate a pathology of the subcortical brain structure, in the blind are connected with the physiologic process of compensation and contribute to an increase in the tone of a cortex deprived of the influx of visual afferentation.

A number of authors inform us that in deaf-blind children, before instruction, there are frequently symptoms of inhibition of the central nervous system (Hofgaardt, 1890; Yakimova, 1947; Sholl, 1940; Arnould, 1948; Yarmolenko, 1961). These deaf-blind children did not show any initiative or sociability and were immobile, sometimes staying in one place or holding one position for hours. It is interesting that the same children, along with passivity and inertia showed periodic outbursts of sudden violence.

An admissible proposition is that a lowering of the cortical tone, caused by an interruption of afferentation from the two excluded analyzers is the basis of the passivity and inhibition of the deaf-blind. Lowering of the cortical tonus can also explain the outbursts of agitation as it is known from a number of pathophysiologic and clinical investigations that lowering of the cortical tone leads to dis-inhibition of the subcortex.

Naturally the question arises how there can be any normal activity in the blind with this background of lowered cortical tone. One can suppose that normal activity has as its basis the enormous compensatory abilities of the central nervous system.

Research on the electrical activity of the brain of blind and deaf-blind people supplies convincing evidence of the development of compensatory processes. As it was shown one observes in the blind, along with a drop in the number of electrical oscillations in all the areas of the cortex, the transfer of the focus of maximum electrical activity into the central parts of the cortex. The rolandic rhythm is observed much more often on the EEGs of the blind than on those of sighted people. This rhythm begins to form a few months after loss of sight and is particularly well pronounced in cases of congenital or early blindness. As visual acuity increases, the number of cases with the presence of rolandic rhythm decreases. All these observations allow us to advance a hypothesis about the connection between rolandic rhythm and the compensatory increase in the activity of the kinesthetic analyzer. It seems that one of the proofs of the correctness of this thesis is the better saliency of rolandic rhythm found on the EEG of the left hemisphere of the cortex of the blind. This hemisphere is more closely connected with the right hand, which generally takes the active part in the processes of touch.

Therefore in analyzing the EEGs of the blind we are confronted with two different processes: the lowering of the cortical tone, reflected on the EEG by the lowering of the amplitude of all electrical oscillations; and the compensatory increase in the activity of the kinesthetic analyzer, revealed in the transfer of the focus of maximum electrical activity into the central areas of the cortex along with the formation of rolandic rhythm. In the simultaneous existence of these two processes one may find an explanation of the contradictory facts pertaining to the functioning of the intact sensory systems (safe analyzers) in blind people.

Thus, certain authors like Heller (1892), Griesbach (1899), Kunz (1902), Gritchley (1953) describe a lowering of the auditory and tactile perception in the blind, while at the same time other researchers (Stern, 1895; Yarmolenko and Belikova, 1930; Stanley, 1879; Krogius, 1909; Zhukovskaya, 1930; Murzaeva, 1935; Zemtsova, 1956) indicate an increase of the preserved forms of sensitivity.

Trying to reconcile those opposed opinions Burklen (1934) explains the superiority of the blind in the sensory sphere in comparison with sighted people as due to their extensive use of these senses. Burklen indicates that there is an initial sensory deficiency in the blind, suggesting at the same time the possibility that the preserved sensory channels (safe analyzers) are sharpened. According to him sighted people, after long practice could achieve an even greater excellence in this respect.

The data presented confirms this opinion: that on the background of the depressed cortical rhythm, reflecting a lowered cortical tonus, there is a new focus of rhythmical electrical activity formed that is related to the strengthened action of the preserved kinesthetic analyzer.

Therefore, the EEG reflects the complex functional reorganization that takes place in man's central nervous system after loss of vision, which is the leading afferentation in the human.

When elaborating the therapeutic and pedagogic measures directed towards compensation for the defect produced by blindness, we must take into account the neurodynamic shifts, arising in the central nervous system.

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COMPUTER PROGRAMMER TRAINING FOR THE BLIND AND VISUALLY IMPAIRED

A CASE FOR QUALITY STANDARDS AND PROFESSIONALISM

I. Constance Walker*

PURPOSE

The purpose of this paper is to specify a bench-mark standard for the quality training of blind and visually impaired computer programmers. It describes training methods which, on the basis of several years of experience, have produced graduates who are competent. Programming is a professional endeavor and, therefore, must be performed by personnel who are equipped to function successfully in the programming environment.

Preparation for a career in computer programming is as exacting as that for other professional disciplines. The act of training implies an obligation to provide a useful, productive experience which will enhance an individual's ability to contribute to himself and to society. To proffer or accept anything less than the highest standards of excellence consistent with the present state-of-the-art is an injustice both to the student and to the profession. This principle is the theme of this paper. I plan to demonstrate that appropriate preparation for a career in programming can indeed be rewarding.

Other sections of this paper are devoted to an examination of the training of the blind and visually impaired in a computer environment. Standards for testing and training, what to expect from the visually impaired as students, economic factors, sociological impact and an evaluation of the program are covered. The final section offers a summary and conclusions.

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INTRODUCTION

Tradition and Stigma

Historically, the blind have been underachievers compared with the sighted, not for lack of ability, but because resources and the opportunities to achieve have been withheld.

Being deprived of one of the senses is not an insurmountable hardship. But to be ranked as a second-class citizen because of blindness is a sociological phenomenon that can be eliminated through education and understanding.

The blind and visually impaired can survive in a sighted world by developing special skills that are only slightly different from those that allow a sighted man to exist in his environment.

The blind world has contributed its share of gifted citizens to our culture--Helen Keller, John Milton, and Homer are some of the giants commonly cited. But most of the blind, like the majority of the sighted, fall somewhere between total dependence and brilliance. And like those who can see, the blind can learn, enjoy rewarding and productive careers, grow professionally, and excel.

Many chances are now being made available. Courses in rug weaving and other make-work skills for some are giving way to those promising a future that is a real part of our economic life. The blind person increasingly has new horizons to look forward to, provided those seeking to guide him can divorce sentiment and maudlin sympathy from constructive, creative, and compassionate concern.

Helping the blind attain "equality" involves education at the level appropriate to the individual's capabilities and potential. To train a blind man for a job which takes less skill than he is capable of is, in the current vernacular, a "cop-out" and denies him the truly satisfying status of dignity and independence as an individual, as well as losing a valuable human resource to society.

Potentials of the Blind in the Data Processing Field

It has been proven that intelligent people can be and are successful in the data processing field. There is every reason to believe that the blind also fall into this category. Opportunities exist and, when adequately trained, the blind can expect unlimited potential for achievement and advancement. Specific qualities found in the blind, such as retentive memory, analytic thought processes, attention to detail, ability to handle coded forms of communication, etc., also are qualities found in and required of programmers.

Computer Technology Job Spectrum

There is, of course, a broad spectrum of jobs within the computer sciences and industry. There are those that apply to the computer itself: the hardware-circuit designers, lab technicians, manufacturers; those who handle or operate the computer causing work to be performed--they are the computer operators, tape library clerks, and support personnel. There are also the programmers--they are those who prepare instructions which cause the computer to perform a given task. The instructions created to perform a task are a program and programs are called software. In the large and sprawling computer technology, we are concerned only with the training of programmers or software specialists.

Within the programming field itself, there are several levels and kinds of programmers. Training should be aimed at assuring that the entry level of graduates is at the professional level and sufficient to prepare them to progress upward from there.

Job Descriptions

The following brief descriptions may serve to define basic programming job levels:*

Coder, a nonprofessional classification, one who writes computer code from well-defined outlines and is, in general, a clerical assistant to a programmer. He does not design, debug or test programs.

Programmer, one who, as a professional, creates problem solutions to be implemented on the computer. He is concerned with the design, structure, testing, verification and documentation of programs.

Analyst, one who is generally a programmer but is aware of the total system and is concerned with system analysis and synthesis, calling on a broad range of experience and knowledge.

User, one who is not a programmer but is able to use the computer as a tool to aid in particular problem solutions. Most users are from other disciplines, for example, scientists, engineers and the like.

Perils of Nonprofessional Training

Programming is an exacting, demanding profession. Training that does not create a potential professional can lead to deleterious effects both to the computer field and to the individual.

There is a computer in everyone's present and most assuredly the future so it must be the province and, indeed, obligation of all involved in the training of programmers to insure

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*Actual SDC job descriptions, California State and Dictionary of Operational titles will be found in Appendix 1. It should be noted that SDC's job descriptions are more demanding and detailed as they represent our own professional requirements. SDC does have a job classification of programmer trainee, but this applies only to the actual training period.

the highest competence. Inaccuracies, overlooked relevent variables and errors made by programmers can cause serious delays and problems in day-to-day activities and may even excite international crises.

PROGRAMMING: THE CASE FOR PROFESSIONALISM

Quality of Training

Some of the liveliest and most durable debates on and off university campuses have centered around the question: What is authentic professional status among occupations? While few authorities agree precisely, most definitions do include some version of these four points enumerated by Bernard Barber:

A high degree of generalized and systematic knowledge.

An orientation primarily toward the community rather than individual interest.

A high degree of self-control through internalized codes and voluntary organizations.

A system of rewards viewed as symbols of work achievement, not as ends in themselves.

Given Dr. Barber's definition, how does programming stack up as a profession? More to the point, how does its status influence the quality of training offered prospective programmers?

To quality as a professional one must: have a license, be accredited by a recognized authority, be a member of a professional organization or some other distinctive means. Professionalism is evidenced mainly in the behavior of the individual. He is dedicated to his job and concerned with its social implications.

To provide training for programmers in preparing them to be professionals requires great concern for the future of not only the individual but also the industry.

Standards for Training

System Development Corporation makes the following observations when specifying a training experience:

1. The goals and expectations of the training are established for the total training experience.

2. An individual's experience and personal needs are considered as important to his success as his capability to understand. (Having trained thousands of programmers has verified that a successful training experience is only achieved when instruction is adapted to the individual.)

3. Undertraining is confusing and degrades an individual's performance more than no training at all.

4. A programmer cannot be made out of a person who does not have the ability to perform in the computer environment.

Training Program at System Development Corporation (SDC)

SDC's training program is recognized as a model of professional excellence and has produced programmers who traditionally display flexibility and leadership in the profession.

More than 4,000 sighted programmers throughout the country have received training at SDC during the past 14 years. SDC has done this training to meet its own contractual commitments as it is one of the country's largest software houses. To insure continued excellence on its contracts, the curriculum was designed to guarantee quality graduates. An instructional staff with experience, judgment, and a demonstrated professional competence is required for this kind of program.

To qualify for internal training, SDC employees usually must be college graduates, preferably in mathematics or the hard sciences.

Prospective trainees must also pass an aptitude test and demonstrate in a personal interview that they have a sincere interest in programming as a career. Success on all selection screens, however, is no guarantee that the student will be able to pass the course. About one of every ten sighted trainees has been unsuccessful in meeting course objectives.

Program for the Blind and Visually Impaired

In 1966, when we were asked to design a curriculum and undertake the instruction of blind and visually impaired programmers, it was decided that the course content should be as rigorous as that provided for sighted employees. It was recognized that anything less would be a disservice.

Candidate Selection and Testing

Programming is an intriguing profession. It is virtually impossible to be successful as a programmer if a person is not enchanted with it. Incompetent people, incorrectly classified as programmers, are apt to be extremely discontented in their work. Therefore, the selection and testing of prospective candidates cannot be over-emphasized.

The initial screening, to date, has been done by the California State Department of Rehabilitation. Clients are reviewed as possible candidates with special attention given to health, mobility, and general emotional stability to assure that the prospective student can accommodate the rigors of our training. Educational background is reviewed and transcripts obtained of high school and college performance. We look for at least two years of college, an interest in math and the physical sciences, and a grade point average over 2.5. These factors together with a demonstrated interest in programming make the applicant eligible for further testing.

The initial testing also is done by the State Department of Rehabilitation and is administered and evaluated by the State psychologists. SDC has established acceptable cutoff points and generally adheres to them. Tests used are:

1. Primary Mental Abilities Reasoning Sub-Test (Cutoff point 25 out of 30),
2. Wechsler Adult Intelligence Scale (WAIS) (Cutoff point 110-115),
3. Strong Vocational Interest Blank,
4. Curtis Completion Test (or equivalent).

Several studies by SDC psychologists over a ten-year period have established that the correlation between these test scores and success in programming as a career is valid.

If a candidate passes the required battery of tests within the range that we consider acceptable, he is eligible for the personal interview.

Personal Interview

In selecting candidates for training, test results are only part of the process. The battery of tests are valuable screening devices, but the real selection is determined in the personal interview.

Many studies have been made to try to identify a potential programmer. The most revealing trait is the activities that a person uses for personal entertainment. Creative hobbies or those requiring study and attention to detail, such as stamp collecting, are valuable indicators. Professional musicians also seem to have an edge.

If an individual plays bridge or chess, enjoys word games, puzzles and other problem-solution-oriented pastimes, he may like programming. Those who prefer watching television and relaxing in a non-stimulating environment--generally people-oriented--may not do well in programming.

Age

Age is, of course, a relevant factor in the selection of candidates for any training effort, but only insofar as older persons may be less apt to adjust to the training schedule and requirements.

Employers don't look favorably on older people unless they have particular talents that are immediately needed; but this applies to all persons, sighted or not. Age discrimination is prohibited by government decree but, in reality, no one wants an old man.

In most cases, ego problems and prior successful achievements that deter willing acceptance of new concepts and learning are more important factors than age.

Home Environment

An individual's home life is an acknowledged factor in his performance away from home. In the case of a blind person, it may have an even more important bearing on his success. If he is free to do homework, relax in a pleasant environment, and devote time and energy to advancement without the interference of family demands, he is fortunate. No one can be expected to perform acceptably in this program if he has outside problems that divert his interest and attention.

Finances

Money is an important consideration in everyone's life. This course is intended to help provide financial security and independence for the graduate. Income from insurance, government agencies or private sources may have a bearing on the incentive to work. A student with enough income to get by may not be willing to put forth the effort required to complete the course or go to work. This characteristic is, of course, divorced from test results and native capability.

Educational Background

A college degree is important, but a look at the candidate's major may be more enlightening. A major in math, physics, or hard sciences may be good material, since he probably selected the major. A major in the behavioral sciences (psychology, sociology, etc.) should be asked if he selected the major or accepted less than an ideal choice. Programmers are mostly non-people oriented. Art, music, history, English and language majors, to name a few, probably indicate special interests and may warrant investigation.

Grades also require scrutiny. A high grade point average indicates successful performance. An average or low grade point average may result from contributing factors, such as temporary depression, personal problems, etc., that affect the grades but do not give an accurate picture of the present individual.

It should be noted that although math is often considered to be a necessary prerequisite for success in programming, this is not always true. A much more important attribute is the ability to reason logically and be able to follow a thought process to its appropriate conclusion.

Security Clearance

Whether a candidate can obtain a security clearance is important. Many computer installations perform work on government or other classified projects that require all employees to be clearable, possibly to secret or top secret. Banks and insurance companies, while not concerned with clearances, do care about the integrity of their employees.

Health and Physical Characteristics

Good attendance at class and at work is expected. If health problems arise consistently and contribute to poor attendance in class, the student suffers in missed lessons; an unenviable work record may also result. Some employers still equate some diseases associated with blindness, e.g., diabetes, with the "Black Plague," making placement difficult.

Physical appearance and characteristics should be appropriate for a white-collar work environment. If present, the ostrich syndrome should be corrected.

Other Things to Look For

A programmer trainee should be a self-maximizer and anticipate success. Many programming jobs require the individual to do work with little or no direct supervision.

Emotional stability and a low frustration index are other indicators. Disappointments, common in programming, can have a shattering effect upon a person who has spent months preparing a program only to find that specifications have been changed and he must now junk his efforts and start over.

The personal interview covers as many factors as are deemed important. The foregoing are just a few that help determine acceptability. If the candidate passes all the screening, he is ready to start class.

THE TRAINING PROGRAM

The major theme of SDC's training program is to obtain results according to our quality standards. To achieve less is to loose upon the computer technology representatives that the author considers unworthy. With this in mind, the following curriculum was developed.

Curriculum

The eight-month course, conducted at corporate headquarters in Santa Monica, involves approximately 120 classroom hours per month at a rate of six hours per day. The course contains significant portions of SDC's standard employee training program and is designed to prepare the blind student for a programming career in either a scientific or commercial environment. The standard course has been expanded to allot more time to individual instructor/student relationships and is more comprehensive. The reason is that the students, who are non-employees, must be overtrained in order to prepare them to work professionally in any of several different types of computer installations and in either scientific or commercial applications.

The first module of the program introduces the student to the basic concepts of system analysis and design, followed by a description and review of computer hardware. The techniques of problem solving, stressing logical reasoning and sequential thought, are given in-depth consideration to prepare the student to work easily with computers. Students use natural language and a simple symbology that is a subset of a higher-order computer language. This general programming module teaches program design, data organization and manipulation, retrieval techniques and complex data structures. Flow diagramming and numbered statements are the mediums used to indicate program logic.

Following the general programming module, the student is ready to study program design theory. Four weeks are spent in assembly language coding on a general-purpose digital computer; and many phases of program design, testing, debugging, and system integration are explored. Emphasis is placed on scientific-type problems and command and control systems.

The next module involves coding the IBM 360/67 in basic assembly language. Here, business data processing procedures make up the module and commercial applications are stressed.

Students are then given a thorough exposure to the concept of executive routines and operating systems and the communication interfaces required. IBM 360 OS, TOS and DOS with the required JCL (Job Control Language) are used extensively during a four-week period where the students experiment with problem programs on the computer.

Next, higher-order languages are presented. The students learn COBOL and FORTRAN and are introduced to the latest programming languages. Programs are written, compiled, debugged, and tested using any of several computers, leading naturally into a familiarization with assemblers and compilers--how they are designed, how they work, and the restrictions and limitations that affect program design.

The final portion of the course is devoted to a workshop where each student either selects a project to pursue on his own or is assigned to assist in a corporate research project. At the end of this module, each student prepares a paper on his activities and presents a seminar to the class. This phase of the program prepares the student for a realistic work environment and aids in strengthening his independence and self-assurance.

Upon satisfactory course completion, students receive a "Certificate of Completion," attesting to the subjects taken. Any student who does not satisfactorily complete the course will be given a statement attesting to the modules he has completed.

Those who successfully complete this thorough course in data processing are completely qualified to enter the field as computer programmers. With minimum on-the-job training, they will be able to design, test, and implement programs utilizing computer languages to solve significant and difficult problems.

It is a failing of many so-called computer programmer courses that they instruct the student only in a specific and limited language, such as COBOL or FORTRAN, without teaching him the techniques of efficient program design or imparting to him a basic understanding of computer operation logic.

Pedagogical Techniques Involved

The six-hour classroom day usually starts with homework review. Lectures fill the mornings, and afternoons are generally devoted to practice problems to implement the new information. The classroom environment used is the same as that for sighted students. The wall-to-wall chalkboards are used by the instructors for their own orientation and to help maintain continuity of presentation. The lecture material is recorded on tape by the individual students who do their own editing. Notes are sometimes taken in Braille, but tapes are faster and more efficient.

Textbooks are not used as most are out of date before they can be published. Recent documents printed by computer manufacturers are used, requiring sighted readers who are provided by the students. Few of these documents are available in Braille or on tape.

The objective of the class is to prepare the students to function in a sighted environment. Emphasis is placed on the premise that the student can move into a computer installation without requiring modifications to the equipment or procedures just to accommodate him.

The students are encouraged to develop individual techniques in handling tasks--reading cards, segmentation of programs, etc., that will assist them in their independence. There will be times, of course, when they may need to "borrow a pair of eyes," but this is not unusual. Programmers tend to work together and help each other. Braille printouts are discouraged, although a conversion program is available for any student who wishes it.

Few real problems develop during training. The differences in education, work experience and age among the students precipitates some modifications to the curriculum to adapt to individual requirements. The course content is continually updated to present the latest concepts and developments. The changes are evidence of the dynamic, evolving environment necessary to any worthwhile vocational preparation process.

PLACEMENT

The placement of the students is, in general, the province of the State Department of Rehabilitation. However, SDC assists through professional contacts, seminars, and individual guidance. SDC is vitally concerned with the successful and appropriate placement of the graduates, and encourages through design and direction a balance between their skills and the jobs available to them.

One of SDC's regular recruiters instructs the students in the preparation of resumes and, also, rehearses them in interview techniques. He helps them to know what kinds of questions to expect and how to sell themselves to the interviewer. Many of the students use the spring vacation to practice interviewing through their own contacts.

Placement opportunities vary with the economic trends. Geography, applications, and company policies cause the personnel classifications (job descriptions and attendant duties) to vary somewhat in the industry. However, most large computer installations try to be reasonably consistent in coordinating job descriptions and salary scales.

Some schools promise placement as an inducement to enrollment. This is hardly fair unless the schools can really produce. SDC makes no promises of placement. Its responsibility is solely the training. The successful placement of more than 75 percent (of a total of 53) of SDC's graduates testifies to the industry's acceptance of quality. The graduates have found employment with several aerospace firms, computer manufacturers, service bureaus, banks, insurance companies, and even a large metropolitan newspaper. (Appendix 2)

The salary levels vary from average to considerably better than the average starting salary for the industry. Seventeen of SDC's graduates were initially hired as exempt personnel, and 94 percent were exempt within a year. "Repeat business" from one of the larger computer hardware and software firms now employing six of our graduates has been most gratifying.

Most of those not now employed as programmers have returned to school to obtain a degree.

SUMMARY

The idea that anyone can be a programmer is erroneous. Programmers are a special breed. There are already too many inept and improperly trained programmers at work; witness the incorrect telephone bills and bank statements which everyone has encountered. Errors in human judgment are blamed on the computer when the programmer is actually at fault. To pick a field such as programming, which is highly specialized, as a vehicle for less than "capable" people, blind or not, is tantamount to fraud.

Graduates of SDC's training are expected to command at least the standard salary for entry-level programmers. They should possess a knowledge of assembly languages for at least two machines, be skilled in the use of two or more higher-order languages, and be able to design, implement, test, debug, verify, and document programs. The flexibility of the individual is important, enabling him to move freely among various applications. It is the programmer's prerogative, if not necessity, to continue to study and to keep up with the state-of-the-art. While there is still a lack of detailed information on specific aspects of training significant numbers of visually impaired programmers, there have been many promising developments. Programs successfully completed by SDC and several training centers have furnished enough data to confirm that the keen powers of memory, concentration, and analysis possessed by the intelligent blind are bringing a valuable new source of talent to the programming profession.

Conclusion

In a recent report quoted by *Time Magazine*, May 24, 1971, programmers and systems analysts are far and away the most in demand. The need for better trained and more highly qualified programmers is increasing almost exponentially. It is therefore imperative that the training of all programmers be carefully scrutinized and monitored to insure the success of the competent and the maintenance of professionalism in the field.

APPENDIX 1

SYSTEM DEVELOPMENT CORPORATION

Exempt Job Description

Job Title: Computer Programming Analyst

Normal Reporting Relationship:
Section or Group Head; Project/ Program Head

Basis of Exemption: Professional

PRIMARY PURPOSE

Designs, develops, tests, and/or maintains computer programs to satisfy specific corporate contractual requirements.

MAJOR DUTIES

1. Designs or assists in the design of computer programs under the general direction of supervisors or more senior programming personnel to establish and clarify programs specifications, determine and recommend appropriate problem solving methods and means to accomplish desired objectives, establish program formats and constraints, and recommend feasible manpower and equipment requirements.

2. Develops computer programs from approved design specifications by preparing detailed flow diagrams, writing computer language instructions, defining test requirements, utilizing appropriate existing test tools for debugging and verifying programs, and insuring that the generated output conforms to design criteria and specifications.

3. Maintains assigned programs by analyzing generated output and/ or error reports to detect program deficiencies, determining and developing appropriate error corrections, testing corrections to verify their accuracy, and incorporating subsequent modifications into original programs to produce updated versions.

4. Designs, implements, and analyzes tests for computer programs and program systems, utilizing existing test tools, to insure that new programs or modifications to existing programs conform to design specifications. May conduct tests at operational sites to verify compatibility of the computer program with actual operational equipment and with contractor designed computer programs that are part of the total system environment.

5. With minimum guidance prepares such documentation as design specifications, programs descriptions, operating guides, and users manuals to assure that the objectives, instructions and unique features of assigned programs are communicated clearly and effectively to intended audiences.

6. Performs evaluations in the development, implementation, and maintenance of assigned programs including reviewing completed programs for possible refinements, investigating the appropriateness of design change suggestions, determining the utilization of and modification to existing test tools, and verifying that required modifications have been tested and integrated.

7. Communicates and coordinates with customers, users, operations personnel, and other inhouse programmers as required to confirm design specifications, determine most effective implementation procedures, insure sufficient program flexibility to allow smooth integration of necessary modifications,

and develop clearly stated instructions for efficient operations.

8. Maintains and applies a working knowledge of all equipment and program interfaces to facilitate the testing and integration of assigned programs, and keeps informed of system and equipment changes to insure maximum hardware/software compatibility; participates in the preparation and conduct of formal and informal demonstrations for customer review and/or acceptance.

LEVEL SUMMARY

<u>Entry Level - PC 280 (Salary grade 3)</u>

This level is provided for recent college graduates and others with comparable qualifications who have completed formal programmer training and/or a minimum of one year's programming experience. Incumbents at this level typically perform a limited variety of programming assignments and receive relatively close supervision. Assignments are made to maximize exposure and experience to provide the basis for further growth.

<u>Second Level - PC 260 (Salary grade 6)</u>

Incumbents at this level possess a minimum of two years of experience and perform a wider variety of programming assignments than entry level programmers. They typically concentrate on specific phases of programming within a particular system while expanding and developing their overall technical proficiency and knowledge of the system as a whole.

They work independently on most assignments, receiving only general direction on some aspects of their work. They are expected to make recommendations which may result in the modification of existing test and production tools. Erroneous decisions or recommendations would cause delay in program schedules and result in additional manpower and monetary expenditures.

Job Title: Computer Programming Analyst - Senior

Normal Reporting Relationship: Group Head, Section Head

Basis of Exemption: Professional

PRIMARY PURPOSE:

Designs, develops, tests, and/or maintains computer programs and/or program systems to satisfy specific corporate contractual requirements.

MAJOR DUTIES:

1. Designs computer programs and/or program systems to meet customer requirements by performing such duties as meeting with customer representatives and in-house users to establish and clarify program specifications, determining and recommending appropriate problem solving methods and means to accomplish desired objectives, establishing program formats and constraints, and recommending feasible manpower and equipment requirements.

2. Develops computer programs from approved design specifications by preparing detailed flow diagrams, writing computer language instructions, devising appropriate tests for debugging and verifying programs, and ensuring that the generated output conforms to design criteria and specifications.

3. Maintains assigned programs by analyzing generated output and/or error reports to detect program deficiencies, determining and developing appropriate error corrections, testing corrections to verify their accuracy, and incorporating subsequent modifications into original programs to produce updated versions.

4. Designs, implements, and analyzes large scale system tests to verify that the computer program system operates under a wide variety of conditions. Utilizes all available system

components to provide inputs for, or produce and evaluate outputs from, the program system. Directs testing activities by designing and/or specifying special test programs and techniques, supervising the activities of other programmers participating in the test, coordinating and scheduling test requirements provided by other contractors and operational personnel, and conducting test briefings and de-briefings.

5. Responsible for preparing such documentation as design specifications, program descriptions, operating guides, and users manuals to assure that the objectives, instructions and unique features of assigned programs are communicated clearly and effectively to intended audiences.

6. Performs evaluations in the development, implementation, and maintenance of assigned programs including assessing existing software for potential application, reviewing completed programs for possible refinements, investigating the appropriateness of design change suggestions, verifying that required modifications have been tested and integrated, and insuring that revisions have been made to affected documentation.

7. Serves as prime liaison representative for assigned programs and/or program systems by communicating and coordinating with customers, users, operations personnel, and other in-house programmers to confirm design specifications, determine most effective implementation procedures, insure sufficient program flexibility to allow smooth integration of necessary modifications, and develop clearly stated instructions for efficient operations; acts as a consultant on the capabilities, limitations, operations, and contents of assigned programs.

8. Maintains and applies a working knowledge of all equipment and program interfaces to facilitate the testing and integration of assigned programs, and keeps informed of system and equipment changes to insure maximum hardware/software compatability; conducts formal and informal demonstrations for customer review and/or acceptance.

9. May function in a technical lead capacity with responsibility for a specific project or task; when acting in this capacity, determines and establishes realistic schedules to meet established completion dates, orients project members concerning task requirements and modifications, monitors and evaluates the progress of assigned projects, and coordinates with external and internal customer/corporate representatives to insure an effective, reliable end product.

LEVEL SUMMARY

Incumbents at this level perform advanced programming assignments with little or no direct supervision. Their technical proficiency has matured to a point where they are capable of visualizing and developing total program systems as opposed to individual programs within a system. They are expected to conceive and design new test tools and techniques. Erroneous decisions or recommendations would cause serious program delays and schedule slippages and result in considerable additional manpower and monetary expenditures.

Job Title: Computer Systems Specialist

Normal Reporting Relationship:
Group Head, Branch Head

Basis of Exemption: Professional

PRIMARY PURPOSE:

Responsible for the design, development and maintenance of advanced computer programs and/or program system to expand corporate capabilities in the programming field, provide more efficient and economical computer program systems, and effectively satisfy specific contractual requirements.

MAJOR DUTIES:

1. Designs computer programs and/or program systems to solve complex problems and meet corporate and customer needs by applying programming expertise and advanced mathematical concepts to determine equipment and system requirements, establish working parameters and formats, identify potential problem areas, insure system flexibility to accommodate future system refinements, and provide maximum hardware/software compatibility.

2. Serves as prime customer contact on major contracts and projects by advising customers on the capabilities and limitations of corporate program systems, negotiating to modify requirements to fit system capabilities, and communicating any system changes that affect contractual commitments; acts as consultant to senior programming personnel in resolving difficult technical problems affecting specific projects.

3. Maintains assigned programs by analyzing generated output and/or error reports to detect program deficiencies, determining and developing appropriate error corrections, testing corrections to verify their accuracy, and incorporating subsequent modifications with original programs to produce updated versions.

4. Performs evaluations in the development, implementation, and maintenance of complex programs or systems including assessing existing software for potential application, reviewing completed programs or systems for possible refinements, investigating the appropriateness of design change suggestions, verifying that required modifications have been tested and integrated, and insuring that revisions have been made to affected documentation.

5. Responsible for producing or directing the production of documentation describing program and/or system criteria, specifications, descriptions, operating instructions, and unique characteristics; may author or co-author reference manuals, user's manuals, operating guides, and similar program and system documents.

6. Maintains an up-to-date knowledge of current advancements in the programming field by attending and participating in professional seminars, briefings, lectures, and conferences; reviews and may publish professional papers, research documents, technical journal articles, and similar documentation relating to the data processing and allied fields.

7. May function in a technical lead capacity, responsible for the implementation and integration of a total program system or subpart thereof; performs a variety of duties in this connection including delegating responsibility for specific portions of the system to individual team members, establishing realistic schedules and completion dates, monitoring and evaluating the progress of each system component, and insuring that the total system is a tested, integrated, reliable end product.

LEVEL SUMMARY

The Computer Systems Specialist Classification

Incumbents at this level are considered to be emerging experts in the programming field. They are given assignments that typically involve the design and development of difficult and complex programs and often include the design and development of complete or partial program systems. They are further required to conceive and develop new testing and programming techniques or to make innovative applications of existing techniques. The majority of their assignments are given in terms of broadly stated objectives and frequently require the conduct of independent research studies to solve specific corporate problems. In accomplishing these tasks, they receive only a minimum amount of supervision and technical work direction. Their assignments frequently require internal and external liaison with personnel at the Group Head level or above, and they often represent the company as prime customer contact on major contracts or projects. Erroneous decisions or recommendations would normally result in failure to achieve goals critical to the major objectives of the organization.

Job Title: Computer Systems Specialist - Senior

Normal Reporting Relationship: Branch Head, Department Manager

Basis of Exemption: Professional

PRIMARY PURPOSE:

Responsible for the conceptualization, design, development and maintenance of advanced computer programs and/or program systems to expand corporate capabilities in the programming field, provide more efficient and economical computer program systems, and effectively satisfy specific contractual requirements.

MAJOR DUTIES:

1. Conceptualizes and designs computer programs and/or program systems to solve complex problems and meet corporate customer needs by applying programming expertise and advanced mathematical concepts to determine equipment and system requirements, establish working parameters and formats, identify potential problem areas, insure system flexibility to accommodate future system refinements, and provide maximum hardware/software compatibility.

2. Represents the corporation as a prime spokesman in presenting technical briefings to customers and potential customers on the operational capabilities and applications of SDC developed program systems; acts as a consultant to customers and programmers concerning the use, operation, modification, and revision of system features.

3. Performs evaluations in the development, implementation, and maintenance of complex programs or systems including assessing existing software for potential application, reviewing completed programs or systems for possible refinements, investigating the appropriateness of design change suggestions, verifying that required modifications have been tested and integrated, and insuring that revisions have been made to affected documentation.

4. Conducts special technical studies of existing programming systems and equipment configurations, and researches existing body of data processing information to determine feasibility of maintaining or modifying inhouse systems and configurations in solving new problems and/or satisfying additional customer requirements; develops system design criteria or recommends system revisions on the basis of these studies.

5. Maintains an up-to-date knowledge of current advancements in the programming field by attending and participating in professional seminars, briefings, lectures and conferences, and by reviewing and/or publishing professional papers, research documents, technical journal articles, and similar documentation relating to the data processing and allied fields.

6. May function in a technical lead capacity responsible for the implementation and integration of a total program system or subpart thereof; performs a variety of duties in this connection including delegating responsibility for specific portions of the system to individual team members, establishing realistic schedules and completion dates, monitoring and evaluating the progress of

each system component, and insuring that the total system is a tested, integrated, reliable end product.

LEVEL SUMMARY

The Computer Systems Specialist - Senior Classification

There are two salary grade levels of the Computer Systems Specialist - Senior Classification, salary grades 11 and 12. Incumbents at both levels are considered to be recognized experts in the programming field who are expected to perform their duties on an independent basis. In this respect, they frequently determine, plan, and develop their own assignments. While personnel in the Computer Systems Specialist classification are mainly concerned with current operational programming projects and programs, incumbents in the Specialist - Senior classification are distinguished by the fact that the majority of their responsibilities involve the conceptualization and development of new programming systems. They further are required to perform independent research studies of new developments in software/hardware technology to determine the technical feasibility of these major programming efforts. The decisions or recommendations made by these personnel with respect to system development or modification frequently influence corporate policy and have a major impact on contractual negotiations, marketing efforts, and corporate commitments. Incumbents are required to interact with Department/Division Managers and senior technical staff personnel internally and with equally high level customer representatives externally.

The distinction between the two levels is such that assignment to the higher level classification is based primarily on the incumbent's personal qualifications and demonstrated past accomplishments in the programming field. They are regarded by corporate management as clearly among the most outstanding in their professional field and are viewed as indispensible company resources.

The above statements reflect the general level and nature of the position and are not to be construed as all-inclusive.

Prepared by Salary Administration, December 1966

CALIFORNIA STATE PERSONNEL BOARD

Specification

Programmer I, Electronic Data Processing

Definition

Under supervision, to program problems of simple to moderate difficulty and clearly defined segments of large complex programs by preparing block diagrams and writing computer instructions for processing nonscientific data on electronic and electric data processing equipment; to develop program proof tests; to revise existing programs and procedures; and to do other work as required.

Job Characteristics

The class of Programmer I is the apprentice and first journeyman level in the electronic data processing programming series. Promotion will be to the class of Programmer II, Electronic Data Processing.

Typical Tasks

Participates in the study of electronic data processing applications, the definition of objectives and the processing requirements of applications; translates problem statements and block diagrams into series of coded and detailed operating instructions; assists in preparing block diagrams on complex problems; programs problems of simple to moderate difficulty and clearly defined segments of large complex programs; assists in tests of coded programs and in making revisions to eliminate errors and excess machine time; studies the principles and techniques of programming, and the work processes and methods of the agency; may operate complex electronic data processing equipment; may analyze machine stoppage and initiate or recommend needed changes.

Minimum Qualifications

Experience. Six months of experience programming data processing applications for electronic computers, and

Education. Either completion of the requirements for an associate of arts degree with a major in data processing; or

Successful completion of a programming curriculum by a resident school which includes actual programming experience and at least 200 hours of classroom instruction. (Partial completion of this requirement may not be combined with other patterns to gain qualification.) (Additional qualifying experience may be substituted for the required college education on a year-for-year basis.)

(Full-time paid work experience in the California state service in program areas which are automated may be substituted for the required college education on a year-for-year basis by applicants who have at least six semester hours of college-level training in Data Processing or mathematics or on the basis of two years of the same experience being equal to one year of college.) and,

Knowledge and Abilities

Knowledge. Electronic computer programming; electronic computer systems; mechanical punch card processing equipment, techniques and procedures; clerical processing techniques and procedures; statistical methods and procedures.

Ability. Analyze data and draw sound conclusions; analyze situations accurately and take effective action; speak and write effectively; prepare clear, complete, concise reports; work with others and gain their respect and confidence, and,

Special personal characteristics. Willingness and ability to accept increasing responsibility and perform work requiring a high degree of mental concentration.

Additional Desirable Qualifications

Satisfactory completion of recognized courses in electronic computer programming.

Monthly Compensation

$746 $783 $821 $863

(Four-step range)

Salary information for this class was correct on 10/23/70. Any subsequent salary changes have not been recorded.

Work Week Group

4A

Programmer, Detail (Clerical) 219.388

Junior programmer; program coder.

Selects symbols from coding system peculiar to make or model of digital computer and applies them to successive steps of completed program for conversion to machine processable instructions: Reads and interprets sequence of alphabetic, numeric, or special characters from handbook or memory for each program step to translate it into machine language or pseudo (symbolic) code that can be converted by computer processor into machine instructions. Records symbols on worksheet for transfer to punch cards or machine input tape. Marks code sheet to indicate relationship of code to program steps to simplify debugging of program. Confers with programming personnel to clarify intent of program steps. Usually works as understudy to Programmer, Business, performing such additional tasks as converting flow charts and diagram of simple problem from rough to finished form, or making minor changes in established programs to adapt them to new requirements.

Programmer, Business (profess. & kin.) 020.188

Digital-Computer Programmer. Converts symbolic statement of business problems to detailed logical flow charts for coding into computer language and solution by means of automatic data-processing equipment: Analyzes all or part of workflow chart or diagram representing business problem by applying knowledge of computer capabilities, subject matter, algebra, and symbolic logic to develop sequence of program steps. Confers with supervisor and representatives of departments affected by program to resolve questions of program intent, output requirements, input data acquisition, extent of automatic programming and coding use and modification, and inclusion of internal checks and controls. Writes detailed logical flow chart in symbolic form to represent work order of data to be processed by computer system, and to describe input, output, and arithmetic and logical operations involved. May convert detailed logical flow chart to language processable by computer. Devises sample input data to provide test of program adequacy. Prepares block diagrams to specify equipment configuration. Observes or runs tests of coded program on computer, using actual or sample input data. Corrects program errors by such methods as altering program steps and sequence. Prepares written instructions (run book) to guide operating personnel during production runs. Analyzes, reviews, and rewrites programs to increase operating efficiency or adapt to new requirements. Compiles documentation of program development and subsequent revisions. May specialize in writing programs for one make and type of computer.

Programmer, Engineering and Scientific (profess. & kin.) 020.188

Programmer, Technical

Converts scientific, engineering, and other technical problem formulations to format processable by computer: Resolves symbolic formulations, prepares logical flow charts and block diagrams, and encodes resolvent equations for processing by applying knowledge of advanced mathematics, such as differential equations and numerical analysis, and understanding of computer capabilities and limitations. Confers with engineering and other technical personnel to resolve problems of intent, inaccuracy, or feasibility of computer processing. Observes or operates computer during testing or processing runs to analyze and correct programming and coding errors. Reviews results of computer runs with interested technical personnel to determine necessity for modifications and rerun. Develops new subroutines for a specific area of application or expands on applicability of current general programs, such as Fortran, to simplify statement, programming, or coding of future problems. May supervise other programming personnel. May specialize in single area of application, such as numerical control, to develop processors that permit programming for contour controlled machine tools in source oriented language.

Programmer, Chief, Business
(profess. & kin.) 020.168

Coordinator, computer programming; lead programmer

Plans, schedules, and directs preparation of programs to process business data by electronic data processing equipment: Consults with managerial and systems analysis personnel to clarify program intent, indicate problems, suggest changes, and determine extent of automatic programming and coding techniques to use. Assigns, coordinates, and reviews work of programming personnel. Develops own programs and routines from work flow charts or diagrams. Consolidates segments of program into complete sequence of terms and symbols. Breaks down program and input data for successive computer passes, depending on such factors as computer storage capacity and speed, extent of peripheral equipment, and intended use of output data. Analyzes test runs on computer to correct or direct correction of coded program and input data. Revises or directs revision of existing programs to increase operating efficiency or adapt to new requirements. Compiles documentation of program development and subsequent revisions. Trains subordinates in programming and program coding. Prescribes standards of terminology and symbology to simplify interpretation of programs. Collaborates with computer manufacturers and other users to develop new programming methods. Prepares records and reports.

APPENDIX 2

Survey Results of SDC's Computer Programmer Training Program for the Blind

Since its inception in 1966, 71 persons have been enrolled in SDC's computer programmer training program for the blind and visually impaired. Of this number 36 were totally blind.

Because of voluntary terminations and other standard causes of attrition, the total number of graduates was 53, twenty-five of whom were blind.

Of the 53 graduates, at least 36 are or have been employed as computer programmers (one is presently an instructor in SDC's training program for the visually impaired). Twenty-one of these are visually impaired; 15 are totally blind.

Of the remaining 17 graduates, five returned to school; three entered other fields; one remained in the field and is currently an independent programming consultant; three are unemployed; and five did not respond to survey questionnaires.

Two of those initially employed as programmers have left the field--one to enter the seminary and another who retired because of health problems.

Twenty-two have worked on a job more than one year.

From a technical standpoint, 26 are working in higher order computer languages and another eight are working with assembly languages. Almost 50 percent (17) report to learning an additional language on the job, and all 36 claim knowledge of at least four computer languages. Nearly 70 percent (22) know five or more computer languages.

In 1966, the graduates began working for a minimum of $585 monthly. The maximum during the next three years was $900. Between 1970-1971, the minimum rose $115 to $700 while the maximum increased nearly ten percent to $965.

The training class of 1968 produced the highest ratio of graduates to enrollees when 12 out of the original 13 graduated. The 1971 class had the lowest ratio of graduates, eight out of 15.

Those employers who do hire the blind and visually impaired seem satisfied with their decisions. More than 15 firms and civil service agencies have hired the graduates, and 25 percent (5) have hired at least one more graduate from subsequent classes. These results more than justify high quality training. The success of the majority of the graduates is more than individually gratifying as it demonstrates that the blind and visually impaired can achieve a rewarding career in a specialized field, one which, until recently, was considered the exclusive domain of the sighted. It is our firm belief that the doors have begun to open and that the blind will soon take their deserved place among people.

THE ASSESSMENT AND PLACEMENT OF THE BLIND WORKER IN INDUSTRY

L. S. Watson*

THE PROBLEM

The Republic of South Africa, in common with the rest of Africa and many other parts of the world, has large reserves of labor clamoring for employment. A large percentage of these work seekers gravitate to the towns and border industry areas in the hope of earning a reasonable living. In many areas competition for work is keen and it is not unusual to see long lines of people outside factories hiring labor.

It is in this situation that we must place the blind worker who is often possessed of little formal education and also very little training. The problem then will take the following form:

1. How is the blind worker to be made economically productive?
2. How is the employer to be convinced that the blind person can, in fact, become a productive unit?
3. How is the blind person to be integrated in the industrial environment without prejudicing his own safety or that of others?
4. How is the blind person to be placed on a market where a surplus of able-bodied workers exists?

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Other factors which will add to this problem are housing, transport, and other social factors which may impinge on the blind person's capacity as a worker.

These problems are by no means insurmountable, although they present a formidable challenge not only to blind welfare, but also to the state and to society as a whole. It is the aim of this paper to give some answers to the problem as set out.

DEFINING SOME OF THE CONCEPTS

Impaired Capacity

In the United States of America it is becoming increasingly common for the concept of "impaired capacity" to be used. It is on this concept that we will concentrate. To say that a person has an impaired mobility capacity or impaired visual capacity is far more meaningful than to say merely he is disabled. To say that a person's total capacity is impaired implies that there is some residual capacity left. In the case of the blind, for example, his capacity is impaired by the fact that he is unable to see, but the rest of his capacity may be unimpaired in any way. This remaining capacity is what we refer to as residual capacity.

Blindness

Blindness has best been defined as loss of vision to an extent that the person is unable to perform any task for which vision is essential. This means that the person may have some visual acuity, usually below 6/60, or a very restricted field of vision. The criteria of blindness are very carefully laid down in the Blind Persons Act.

Partially Sighted

When a person's vision is so restricted that he is unable to undertake employment which requires normal vision, even with visual aids, but is not registerable as blind, he is usually referred to as being partially sighted. These cases are often the most difficult to place, as their residual capacity precludes them from occupations which they might otherwise enter, and they refuse to accept employment normally undertaken by the blind.

Rehabilitation

This is a word that I personally do not favor, because it means to restore a person to his former state; which of course, in the case of the blind or any other impairment, is impossible. I prefer personally to define the process of restoring the newly-blinded person to society as reintegration. (Or in the case of the born blind as integration.) We will not belabor this point, however, as rehabilitation seems to be a widely accepted term.

The Ergonomic Approach

Griew defines ergonomics as the relation between the physiological and psychological aspects of the job, on the one hand, and the engineering and methodological aspects, on the other (1963). If a worker is placed in a situation where vision plays no part, then the person performing that task, even though blind, is not handicapped in that situation. One of the functions of a placement officer is, where possible, to eliminate visual factors from the work situation by modification of either the method or the equipment used. Caution should be exercised never to take things for granted.

Griew tells of a man who lost an arm in a car accident. His employers offered him the alternative of premature pension or a job as a lift operator. As it was his right arm, no one, not even the man himself, questioned the wisdom of this until someone asked if he was right-handed. On learning that he was left-handed he was fitted with a prosthesis and returned to his former work as a bookkeeper.

In many cases recently blinded industrial workers can be restored to former employment by simple modification of equipment or the installation of jigs or guides. In the case of the blind the removal of the visual factor from the work situation means in that situation the worker is not impaired.

THE INDUSTRIAL WORKER

The vast majority of blind workers in this Republic ultimately have to be absorbed on the open labor market in industry. As industry depends on the productivity of its labor force we can neither ask, nor can we expect, industrialists to employ unproductive labor out of sympathy or any other consideration. It is essential, then, that blind workers in the industrial field are in all respects fully productive workers. This aim is not as impossible as it may appear on first examination. The average industrial worker in the Republic has a lower production norm than his European or American counterpart due to educational, cultural, and economic factors. Although there is no shortage of labor, there is a shortage of productive labor. This is due largely to poor selectivity, lack of adequate industrial training, and often lack of motivation.

Yet, the blind worker can become a productive worker for the following reasons: He is always carefully selected for the post, ensuring that he has the capacity to perform the job efficiently. He is usually pretrained in a workshop for the blind and is accustomed to industrial discipline and high demand levels. He is given in-service training to ensure that he adopts the most productive and safest method of performing the task. He is normally strongly motivated, as it is usually considered a privilege by the blind to work in a "sighted" situation.

Some conditions are of course necessary if the blind worker is to be such a successful worker. There must be no visual factors to the work. If these exist they must be eliminated, either by altering the method or providing substitutes for vision. The worker or the work situation must maintain a physically stable position. The work should be repetitive in most cases. Noise level and other environmental conditions should not in themselves create a hazard to the worker's safety or efficiency.

PRODUCTIVITY

Independent studies by work study officers in industries employing the blind have found that although the unit production time of the blind worker exceeds that of the sighted, the total output is often higher. Production graphs recording half-hourly production reveal an interesting trend. The blind worker takes longer to reach his peak production than the sighted worker, but sustains his production at a higher level than the sighted worker throughout the day.

Probable reasons for the higher total output of a blind worker are:

1. Less susceptibility to distraction;

2. Not influenced by the production of fellow workers since he cannot watch their performance;

3. Does not slow down when the supervisor is absent and increase speed when he is being observed;

4. Does not leave post and wander about the factory;

5. Usually more strongly motivated than the average sighted worker, since the blind worker considers it a privilege to take his place in a factory on a par with sighted workers;

6. Absenteeism is usually lower than that of the sighted because he values his employment;

7. Cannot easily obtain work in another factory and become a very stable worker.

SAFETY

The employer of blind industrial workers is concerned with their safety. This aspect seems to give rise to an almost irrational fear, not founded on experience, because blind workers have an enviably accident-free record. Since January 1966 *not a single lost shift has been reported through accidents involving blind workers.* This means that a labor force, at present exceeding 250 workers, has not lost a shift in 4-1/2 years. An estimated one million man hours have been worked by blind workers without lost time.

This record is not as surprising as it may appear on the surface. Blind workers are carefully selected and trained; they work in the manner they are taught and do not take short cuts. Blind workers do not wander aimlessly around the plant, eliminating one of the commonest causes of accidents. Distraction is a common cause of accidents in factories. Due to their impairment, blind workers tend to concentrate more, and apply themselves better than sighted workers. Because they depend on their hands, blind workers tend to be more safety-conscious.

Close cooperation is maintained between the South African National Council for the Blind and the National Occupational Safety Association, and placement officers are required to observe industrial safety practices in making placements. No blind worker is placed in any environment which will create a hazard either to himself or to others. Industrialists may therefore confidently employ blind workers--providing they are properly assessed, trained, and placed in jobs suited to their capacities.

THE ASSESSMENT OF THE BLIND WORKER

The Labor Market

Let us look at the structure of the open labor market. This might be described as a pyramid with the vast mass of unskilled workers at the base, narrowing to the top with senior executives and professional workers.

This pyramid rises and narrows steadily, each level flowing into the next. Although there seems to be a dividing line between levels, no sharp dividing lines actually exist, and it is possible, within limits, for a flow to take place in both horizontal and vertical directions. It is rare, however, for workers to rise from the lowest to the highest levels, or from manual to clerical areas. Some industrial psychologists prefer to designate the levels as decision making levels. While there is a sound basis for this argument I feel it is an oversimplification as physiological factors play an important part in determining the level at which a worker can be placed.

Demand and Capacity

In all placements two factors are in fact inseparable, namely, the demand level of the work situation and the capacity of the worker. These factors take two forms, psychological and physiological. These factors may be illustrated in graph form, showing the demand levels in relation to each other (see Figure 1).

It will be noted that as the physiological demand level drops the psychological demand level rises. Most workers, including laborers, do not work beyond 30 percent of their total physiological capacity, and can work to a level of 50 percent of their capacity without endangering health. This total capacity can increase with exercise (Asmussen, 1967). These levels have been accurately measured by Asmussen in Denmark. The IQ of the worker is basic to his psychological capacity, and although he may learn intellectual skills his psychological capacity will always be bounded by this inherent limit.

When placing the impaired a point is often reached at which the physiological capacity of a worker is too low to place him in the lower work ranks and his psychological capacity is not high enough to raise him above these ranks. The only solution to this problem is to place

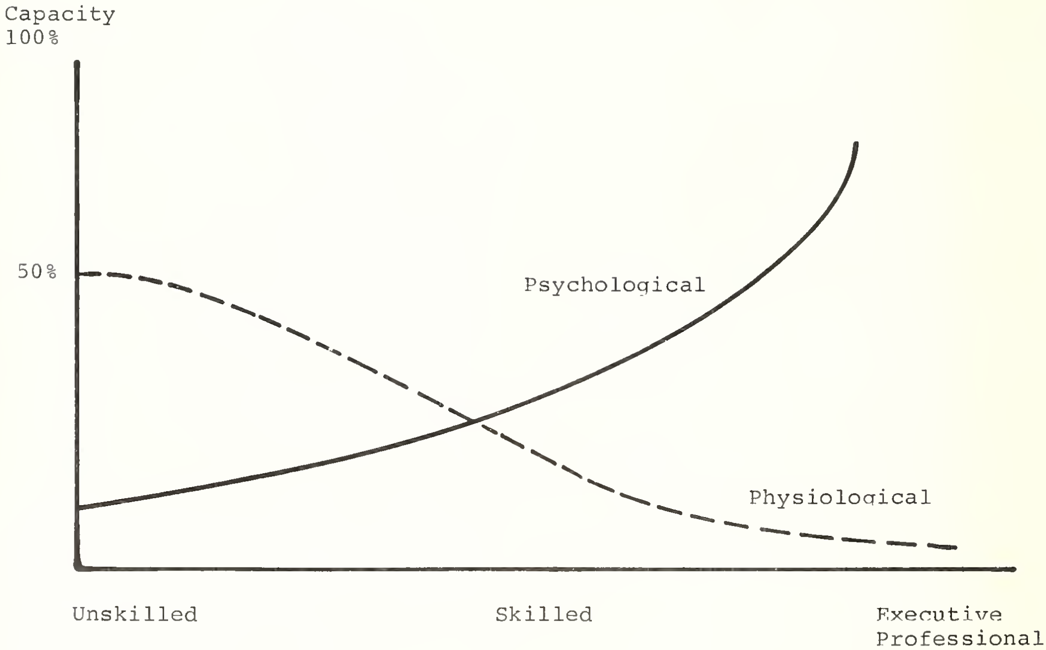

Figure 1

him in permanent sheltered employment or give him a disability grant, the former the preferred course.

The Need for Assessment

Bearing the foregoing in mind, the need for accurate assessment or evaluation of a client's capacity becomes obvious. To place him too far above his physical capacity will endanger his health. To place him too far above or below his psychological capacity will either lead to frustration or complete breakdown. Apparent work instability may also be caused by an incorrect evaluation of the capacity of a worker in relation to the demand level of the work situation.

The Blind Worker

The definition most appropriate to the present discussion is that blindness implies a total, partial, or intermittent deprivation of sight to a degree which prevents work placement for which sight is essential. Blindness may be seen as a gap in the individual's perceptual field which precludes his performing tasks which demand vision. It is possible, however, to reduce the impact of deprivation by retraining the worker to use other sensory capacities more effectively, or to remove visual factors from the work situation. Let us define perception more fully. The definition which I use is functional and, although not accepted by all psychologists, appears to be the most useful for our purpose. Perception may be defined as the synthesis of all sensory stimuli leading to cognitive and rational behavior. From this definition it is but a logical step to say that if the synthesis of all the sensory stimuli other than sight is improved, the impact of the deprivation of sight is lessened as, for example, in hand-ear coordination. Theoretically, some 80 percent of all sensory information in a normal person is gained through seeing. This long-held belief is hardly reinforced by the favorable performance of blind persons in all levels of employment which at one time were considered so visually oriented as to preclude the employment of the blind. This applies particularly to industry.

THE TEST FORM

The form which follows has been designed to systematize the data obtained from the test situation and to enable the testing official to assess total capacity. The placement record is attached to verify the assessment in relation to the work situation. (See form in section on Placement.) All quantitative results are reduced to ratings as follows:

1 = Very Poor, 2 = Poor,
3 = Good, 4 = Very Good.

It will be noted that there is no midpoint or average. This is done for two reasons. In the first place there is no such thing as an average capacity, in fact, although for convenience we may take the average of the good and bad to establish a norm. The second, and possibly the more important reason for our purposes, is that a rating system which has no midpoint prevents the tester taking the easy way out when making qualitative judgments. He is in fact forced to either recommend or fail to do so. This may on the surface appear to be harsh, but in the long run it is in the best interests of the client. To place him in a situation where he is bound to fail, is to do him a disservice. It is better to err on the conservative side and raise the workers demand level should he prove to have a higher capacity than at first realized. This would save both worker and placement officer much unnecessary disappointment.

It is essential to ensure that the client fully understands what is expected of him. If necessary, as when testing the Bantu, an efficient interpreter must be used. Times given for tests must be stringently adhered to, otherwise scores become meaningless and no real norms can ever be established. (Permission must be obtained for the use of some of these tests from the authors, or in the case of the tripod test, from the National

THE SOUTH AFRICAN NATIONAL COUNCIL FOR THE BLIND

Work Assessment

Surname . . . . Date of Birth. . . . .
First Names . . . . Sex. . . . .
Race (or ethnic group). . . . .
Address . . . .

Social and Previous History

Former Employment

Name of Employer   Capacity   From   To

. . . .

Remarks on Former Employment

Reason for termination of previous employment . . . .

Any other relevant data on former employment and work habits. . . . .

Marital Status

Dependents (give details) . . . .

Social Worker's Remarks . . . .

Educational and Psychological

Standard of education . . . . School. . . . .
Other educational qualifications. . . . .
Other qualifications (trade, craft, etc.) . . . .
Intelligence (rating by psychologist if possible) . . . .
Interpersonal relationships . . . .
Ability to make decisions . . . . ____ ____ ____ ____
Reaction to authority . . . . ____ ____ ____ ____
Acceptance of handicap. . . . . ____ ____ ____ ____
Personal appearance and mannerisms. . . . . ____ ____ ____ ____
Any other psychological factors which may influence placement . . . .

Physical

Visual defect . . . .
Cause . . . .
Prognosis . . . .
Acuity (if any) L ____/____ R ____/____ Both ____/____
Field L ____/____ R ____/____
Color Perception L ____/____ R ____/____
Any other physical or sensory disability. . . . .
State of health . . . .
General practitioners report should be attached if possible.

Institute for Personnel Research. It may be taken as read that permission will not be granted for the use of sensory and learned ability tests unless the applicant has a minimum educational standard of matriculant or its equivalent and some experience in personnel selection. Permission will normally be granted automatically to persons in possession of a degree is psychology. These requirements are for the protection of the client and are not intended to create an impression of exclusiveness.)

The author would appreciate it if the results or copies of forms used by others could be forwarded to him to compare findings and verify norms by persons who adopt all or any of these tests.

Personal Information

The first part of the form is self-explanatory, dealing with the name, address, age of the client, etc. Care must be taken to ensure that this information is accurate and complete. Identity numbers should also be given where possible, to avoid confusion, particularly in the case of Bantu who have the same name and address and may not be certain of birth dates.

Social and Previous Work History

This section deals with the social and work record of the client and is intended to give the placement officer some indication of the client's attitude toward work, and his interests. In the case of the newly blind it may be possible to restore him to his former employment. An unstable work history in the case of the blind does not necessarily indicate an unstable personality. This instability may be caused by incorrect placement in the past. It is essential, however, that extreme care be taken when undertaking placements in such cases, as an error may only aggravate the situation and make the client's effort to find stability even more difficult.

Instability may also be due to underlying social problems such as economic pressures which often cause workers to leave a post to get pension contributions, etc. Domestic problems, alcoholism, and many other social factors may underlie drifting. The timely help of a social worker or psychologist may help uncover these problems and even solve them. It is not my intention to claim that work instability does not exist, and that there are no blind persons who are unable to keep a post, but every effort should be made to eliminate all factors which may be causative and responsive to remedial measures. Work habits in former employment may also give an indication of work tolerance, punctuality, etc. This information can usually be obtained from former employers, or from secretary-managers in the case of workers from sheltered workshops.

Educational and Psychological

The educational record of a client gives an indication of intellectual capacity and of interests and intelligence; although intelligence and educational level are not necessarily equated. A person lacking opportunity may have a limited education and yet be highly intelligent. Conversely, a person with a relatively average IQ may by dint of opportunity and perseverance attain a reasonably high educational level. In other words, in the assessment of the client, education must be considered as one factor in relation to others.

Intelligence

Although some indication of this can be obtained by the approach of the client to the test situation, particularly the tripod test, it would be better to obtain a quantitative evaluation from a psychologist. Any other evaluation is qualitative, however, and can at best be a guide. Although this can be of considerable help, care must be taken to ensure objectivity in making these qualitative judgments.

Acceptance of Impairment

One of the most common problems facing rehabilitation and placement officers is the refusal of clients to accept the limitations imposed by

Hearing . . . .

Acuity. . . . . . L ____ ____ ____ ____ R ____ ____ ____ ____

Directional . . . ____ ____ ____ ____

Depth Perception. ____ ____ ____ ____

Noise Tolerance . ____ ____ ____ ____

Tactile 0-4 = 1 4-5 = 2 6-7 = 3 8 = 4 This rating is for the new test.

For texture discrimination ____ ____ ____ ____

Wet and dry . . . . ____ ____

Temperature . . . . ____ ____ ____ ____

Sterognosis . . . . ____ ____ ____ ____

Kinesthesis . . . . ____ ____ ____ ____

Two-Hand Coordination . . . . ____ ____ ____ ____

This must be obtained from the Watson-Murphy Kinesthetic Ability Test Sheet.

Mobility

Indoors, familiar ____ ____ ____ ____, unfamiliar ____ ____ ____ ____

Outdoors, familiar ____ ____ ____ ____, unfamiliar ____ ____ ____ ____

Dexterity Gross ____ ____ ____ ____

Dexterity Finger
1st attempt score . . . . Rating ____ ____ ____ ____

2nd attempt score . . . . Rating ____ ____ ____ ____

Using the Watson Finger Dexterity Test.

Hand dominance. . . . .

Mechanical Aptitude, Tripod

1. Score . . . . Rating ____ ____ ____ ____

2. Score . . . . Rating ____ ____ ____ ____

3. Score . . . . Rating ____ ____ ____ ____

Learning ability . . . . ____ ____ ____ ____

NIPR Test.

Smell . . . . ____ ____ ____ ____

Taste . . . . ____ ____ ____ ____

Work Tolerance

Standing. . . . . ____ ____ ____ ____

Sitting . . . . ____ ____ ____ ____

their impairment. This may be obvious by the client's refusal to accept the ophthalmologist's prognosis or waiting for a "new" cure which to him is just around the corner. In most cases, however, this problem does not manifest itself in such an obvious manner; the client while claiming that he has accepted his impairment will resist all efforts to develop compensating factors. The refusal to learn braille, touch typing, and other techniques of blindness is one of these manifestations; the rejection of mobility aids such as the white cane or a guide dog another.

This rejection may be even more deeply seated and result in psychological blocks, emotional instability, poor work habits, lack of motivation, and other psychological disturbances. In such cases psychotherapy may be indicated. Care must be taken, however, to ascertain that this is actually the problem and that the problem is not caused by totally different factors such as frustration at being unable to find suitable employment.

Interpersonal Relationships and Reaction to Authority

Information on this can be obtained from the staff of the institute where the client has been trained. The tester can also observe the client's attitude in the test situation. The accurate assessment of these factors is of vital importance, especially in the case of the blind. Many of our clients lead a sheltered existence, and as a result are ill equipped to deal with interaction situations and manifest stress symptoms when confronted with these situations. The problem of integrating the blind into normal society is one that has vexed educationalists and rehabilitation centers throughout the world for many years. While not claiming to have the answer to this problem, it is essential to ascertain that an individual is ready to meet the stresses of the open labor market before thrusting them upon him. A breakdown at this level may do irreparable harm to the client if he is placed in an interaction situation beyond his capacity.

Ability to make Decisions

Decision-making ability manifests itself clearly in the practical test situation, the Tripod Test in particular. The approach of the client to other tests such as ear-hand coordination, texture discrimination, etc., manifests this ability to a lesser extent. The manner in which the client responds to decision-making situations at a higher level also gives a strong indication of this capacity. Some psychologists assert that all work situations can be broken down to the level of decision making. While not in complete accord with this view, I believe that it plays a predominant part in both the assessment of the client and the analysis of the demand level of the work situation. May I add that my only disagreement with this viewpoint is that it can lead to oversimplification of a very complex problem.

Other Psychological Factors

Other factors which may have a bearing on placement are job dissatisfaction, insecurity, mannerisms, speech impediments, etc. *Note.* This section is fraught with pitfalls for the tester, and every care should be taken to maintain an objective standard. Psychopathology must not be looked for where none in fact exists. There is the very real danger that an inexperienced tester, confronted with the blind for the first time, might find himself projecting his own attitudes on the client.

Motivation

This factor is probably the most difficult to determine, as a client may appear to be strongly motivated in the test situation and show poor motivation at work. A trial or probationary period may be the only way of determining this factor.

Basic Ability Tests

Visual. As we are interested in the blind and partially sighted

Assessment and Recommendation of Testing Official

. . . .

. . . .

. . . .

Date . . . .   Signature . . . .

Capacity . . . .

Note.

Rating: 1. Very Poor, 2. Poor, 3. Good, 4. Very Good.

Full details on the administration and description of these tests can be obtained from:

The S.A. National Council for the Blind
P.O. Box 1343,
Pretoria, South Africa

we begin this section with the residual visual capacity (or its absence) in the client.

Cause of blindness or visual defect must be given together with the prognosis. If an ophthalmologist's report is not immediately available, one can usually be obtained from the record of his registration or from the records of the institution where he has been trained. If an ophthalmological report is not available the Illiterate "E" chart may be used to determine residual vision.

Color Vision

This may be determined in the case of the partially sighted with color vision charts.

Note. Experience has shown that partially sighted workers with very poor vision often have lower performance levels than workers who are totally blind. This is not as strange as it may appear to be at first sight as partially sighted persons often slow down their actions to the rate at which they can see. It is not uncommon to find a blind assembly worker sitting erect and working rapidly and efficiently while his partially sighted co-worker is stooping over the job and peering intently at what he is doing. In addition to lower output, the worker's work tolerance is lowered further by poor posture. Such workers must be taught to work nonvisually.

Partial sight can be of use, however, where a certain amount of mobility is required in the work situation. This is not to say that totally blind workers are incapable of undertaking tasks which require mobility. This will be dealt with more fully in the section covering mobility. Should the level of vision be relatively high, say 6/60, then the visual factor need not be absent from the demand level of the work situation. This demand must be commensurate with the visual capacity of the worker.

Any Other Physical Impairments

One of the most challenging, but also rewarding, facets of the placement officer's task is the placement of the multiply impaired. With an increasing number of children leaving the schools for the deaf-blind, a great deal of research will be needed in this field. If the nature and the extent of the secondary impairment is known, and the total residual capacity of the client is known, much can be done to restore him to society and a working life. It is not the incapacity, but the total capacity, of the client which matters. Secondary impairments complicate both the assessment of the worker and the determination of the demand level at which he can be placed. To put it another way, if the demand level of a work situation requires no visual capacity and only one hand, then the lack of these capacities in this work situation is no impairment. One has only to think of a well-known personality in blind welfare who is doing a sterling job with just these incapacities.

HEARING

Three functional aspects of hearing are of particular importance for our purposes:

Acuity. It must be determined that the person's hearing acuity is sufficiently sound to enable him to function in a given work area, often in an environment with a high background noise level. This, of course, involves an audio memory for sounds of particular intensity and pitch to enable him to identify a particular sound amid the ground noise.

Directional Sound or Sound Location. In addition to variation between phase and intensity to one or the other ear, giving us sound location; time lag and echo play an extremely important part. For example, assuming a sound of relatively high pitch and intensity to be emitted to the right of the client, the distortion caused may confuse him as to the source until he picks up the echo from, say, the wall on the opposite side. It is the intensity and direction of the echo rather than the sound itself which gives him this indication.

Depth Perception (Hand-Ear Coordination). For our purposes depth perception is tested in conjunction with hand-ear coordination. The ability to determine simultaneously both direction and distance of a sound source is the equivalent of visual depth perception and involves several functional factors: direction (which has already been discussed); intensity in relation to ground noise and echo; sound location is easier in known surroundings but not precluded in unknown surroundings.

THE REVISED TEST USING THE WATSON-MURRAY TEST EQUIPMENT

The test set is comprised of an oscillator, a small movable loudspeaker, and a test board. These cover a wide range of frequencies (30Hz to 6KHz) and intensities. Test data and administration details will be made available as soon as norms have been established. In the meantime, the existing method of testing can be continued.

STANDARD TEST SITUATION

Acuity

Without using an audiometer, the hearing acuity of a client can usually be assessed with a watch. The watch is held at varying distances from the client the side being changed at random. The client is asked whether he can hear the watch, and to indicate on which side. The same watch should always be used; the environment should be quiet. The watch normally used by the author has been heard by clients at distances ranging from six inches to eight feet (in the same environment). The norm appears to be four to five feet.

Directional Hearing

The ability to determine the direction from which a sound originates, and the distance, is of vital importance to a blind person. He must be able to identify the source and direction of sounds in his working environment if he is to be a safe worker. (Imagine, if you can, the situation in which a worker could find himself if he mistook the direction from which a fork-lift truck was approaching!) To test this ability the tester moves from one point to another, asking the client to identify his position. He should be precise and accurate in his identification.

When testing direction it is also advisable to take the client to a moderately busy intersection to determine whether he can identify direction, distance, and speed of traffic.

Note. The difference in pitch between approaching and receding vehicles should be pointed out to the client. His life may depend on it.

	Rating
Failure to identify task direction and distance	1
Inaccuracy in identifying direction and distance	2
Accurate identification of direction, but inaccuracy in identifying distance	3
Accuracy in identifying both direction and distance	4

The tester must not make allowances for the client's inaccuracy, and should conduct the test in surroundings with normal noise level.

Note. In all hearing tests partially sighted clients are blindfolded.

Hand-Ear Coordination

The ability to coordinate hand movements to sound are extremely important to workers on conveyor belts, lathes, presses, and in many other work situations. The test is extremely simple, but nevertheless shows a high correlation with performance in work situations.

The client is seated at a table opposite the tester. The table should be at least three feet wide. The tester places a small weight on the table with a tapping sound. The client is asked to pick it up. The position and distance of the weight is changed a number of times, placing it each time with a tap. The weight should never be placed less than 12 inches from the client and not more than 30 inches. It has been found almost impossible for a client to locate the weight accurately under 12 inches.

	Rating
Random groping	1
Over or under reaching with some idea of direction	2
Definite but slow, or hesitant location	3
Positive, accurate location	4

Note. Laxity in scoring this test can cost the client a hand, or result in severe injury, in the work situation.

Tactile Perception

This capacity plays an important part in textile upholstery, packing, and similar occupations.

The means used to test this capacity is as follows:

A board 15 by 8 inches is used, with discs of varying textures glued in two rows. The diameter of the discs is three inches. Identical textures are glued to pieces of board or hardboard. The textures are laid out as follows:

Fine sandpaper, Medium sandpaper, Coarse sandpaper, Extra coarse sandpaper.

Rexine, satin, fine knit fabric, felt.

The loose boards are mixed and given to the client and he is required to match them.

No. Correct Identifications	Rating
8	4
6	3
5	2
under 5	1

Identification of the top row seems to involve two-point discrimination, while the lower row seems to involve pressure discrimination. Poor performance of many clients indicates that this aspect of tactile perception is not innate to the blind, but like most abilities has to be learned.

Temperature Discrimination

This test has not yet been standardized. The author used two test tubes filled with water. Thermometers were inserted through corks. The temperature of one was raised approximately 5° F. The client must discriminate the warmer from the colder.

This ability is required by workers in processes using heat. The ability to discriminate slight temperature differences on a surface into which a hot plate is set flush may prevent serious burns. The same applies to metal which has been welded. The cautious approach to a joint, feeling for rise in temperature, can prevent burns.

Wet-Dry Discrimination

In some industrial occupations the material, often cold metal, must be wet before processing. The worker, therefore, must be able to feel that the material is wet. The test comprises of giving the client two pieces of metal, one of which has a wet surface, and ask him to identify the wet one. Failure to identify the difference is surprisingly rare, although it does occur.

Rating

A yes-no rating, or quantative 1 or 4 rating.

Sterognosis

In many industrial operations it is essential that the blind worker be able to determine the form of components, not only with the finger tips, but also with the palm of the hand. This demand is characteristic of many gross assembly jobs and some machine operations.

To test this capacity various shapes from 1-1/2 to 2 inches across are cut out of hardboard. The shapes used by the author include a pentagon, star, square, rectangle, oval, circle, and triangle of differing sizes. Some of the shapes are duplicated in different sizes, bringing the total up to ten.

Administration

The shapes are placed in front of the client, who is allowed to feel them. The shapes are then placed, one at a time, in the palm of the hand, and replaced among the others by the tester. The client is then required to select the shape from the remainder, again using his finger tips.

Note. When the shape is pressed into the client's palm he is not permitted to use his fingers, which must be kept away from the shape.

Scoring. 1-4 = 1, 5-6 = 2, 7-8 = 3, 9-10 = 4. The approach by the client to the test situation should also be noted, as "positive," "vacillating," etc.

Kinesthetic Ability and Two-Hand Coordination

A full description of the Watson-Murray test follows. Some comment must be made on rating.

Average Score	Rating
3.1 to 4	4
2.5 to 3	3
2 to 2.4	2
1 to 1.9	1

The importance of this test cannot be overstressed, for it is difficult to visualize an industrial situation which does not demand this capacity at a high level. Even in activities of daily living these abilities are highly significant.

Placements made since the inception of this test show a very high correlation between test results and work performance. In the case of partially sighted workers it has been found that those with a high kinesthetic rating are far less dependent on their residual vision than those with a poor rating.

Kinesthetic memory and intelligence seem to be reflected in test results. Persons with known high intelligence level seem to perform better than those with poor or average intelligence level.

THE WATSON-MURRAY KINESTHETIC ABILITY TEST

The test described in this section was developed with the aid of A. J. Murray.

Significance of Kinesthetic Ability Test

Kinesthesis plays an important part in the daily activities of everyone, whether in a work or domestic situation, or at play.

It is difficult to think of any activity in which this aspect of perception does not play a part. This is in fact the answer to the perennial question asked of the blind, "How do you find your mouth?" The answer should be one word, "Kinesthetically."

It will be seen readily that it is essential to know the degree of kinesthetic ability possessed by the work seeker before placement to avoid accident. This test is a measure of the degree of accuracy of movement, and the limits which can be expected of the worker in a particular situation.

Should a worker have to place his hands within a limit of, say, 3 cm, then it is criminal to place a worker who cannot determine his movements within 21 cm. This applies not only to the blind, but also sighted workers.

Definition

Kinesthesis may be regarded as the sensation of movement of any part of the body, arising from stimulation of receptors in joints, muscles, and tendons; the term also includes knowledge of movements obtained from the receptors in the semicircular canals of the inner ear. The kinesthetic receptors involved in our test are those in the joints, the ligaments, and the semicircular canals.

Joint receptors are the most important source of kinesthetic information in the limbs. There are two types of joint receptors. The type that most frequently occurs is the "spray type," somewhat like the Ruffini organ. These receptors are situated so that when the joint moves, a particular neuron group will fire in every position of the joint. As the joint moves, then, there is a particular firing order with the limb moving in one direction, and another order when the joint moves in another direction. When the joint is stationary the particular receptor that normally fires in that position carries on, firing continuously.

The second type of receptor in the joint is the Golgi organ. This organ is found in the ligaments of the joints and reacts in much the same way as the receptor just described.

The semicircular canals are also responsible for awareness of movement. The information concerning our balance is actually information about what our position in space is, and as we move in space we have a changing pattern of signals from the semicircular canals which are indicative of movement; movement of the whole body in space. As when the arm moves from side to side or from top to bottom in the test we described, the body moves to a certain extent with it, so this form of kinesthesis is also involved in the test to a minimal extent.

Kinesthetic Memory

Just as we have a visual memory, we develop a kinesthetic memory. The Penguin dictionary of psychology defines this as "memory in terms of ideal representation of movement sensations."

It seems evident from tests the authors have made comparing blind and sighted people that there is also, at a higher level, association and correlation between visual and kinesthetic memory. If one looks at a board to see what movement is required to draw a certain figure, one may then close one's eyes and draw it from memory with a certain amount of accuracy. With one's eyes closed this may only be done in terms of an association between visual and kinesthetic memory. After feeling what the required movement is, the blind man will perform the task still more accurately. He is relying only on his kinesthetic memory and possibly, if he were once sighted, on a visual memory as well.

If we are in possession of a kinesthetic memory, we ought then to be able to perform without looking a movement for which we have built up a memory. Test results so far show no correlation between hand dominance and kinesthetic memory or ability. With the above facts in mind we will now describe the test.

Description of Board

The test set is comprised of a sheet of steel, 30 inches (77cm) square, covered with a matte black plastic, on which the test areas are painted in white. There are eight test areas around the periphery of the board, and a ninth in the center. Each test area consists of four concentric squares. The board is structured on squares rather than circles to give an indication of error in movement radially (Figure 2).

Administration

Unless the person to be tested is totally blind he must be blindfolded to eliminate the visual factor.

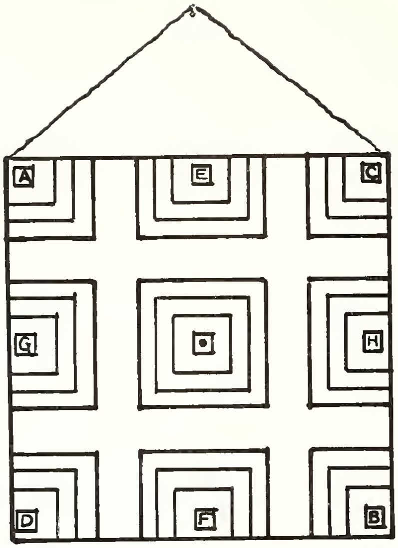

Figure 2. The Watson-Murray Kinesthetic Ability Test

Size of Squares:	Inner No. 4	1.2 inches (3 cm)
	Inner No. 3	3.6 inches (9 cm)
	Inner No. 2	6.0 inches (15 cm)
	Outer No. 1	8.4 inches (21 cm)

The inner squares of the peripheral areas are 1.2 inches (3 cm) from the edge of the board. The squares are alphabetically indexed:

A - Top left

B - Lower right

C - Top right

D - Lower left

E - Top center

F - Lower center

G - Left center

H - Right center

Two magnetic blocks are provided with the test board, each 0.6 inch (1.5 cm) square.

One of the magnetic blocks is placed in square A and the subject is shown its position by placing his right hand on the block. His left index finger is then placed in the center of the center square. He then transfers the block from the square A to the center square and back to square A. This is repeated twice and is not scored (to develop kinesthetic memory of the movement).

On the third attempt the left hand may not be placed on the board, and the score obtained in both directions is recorded. The subject on each occasion is shown the correct position relative to the position he actually reached.

The block must be wholly contained by a square for scoring purposes, otherwise the lower of the two scores relating to the block is awarded, e.g., if the major part of the block is in the center square and part of it projects into the next square, 3 points and not 4 are given.

The test is repeated in alphabetical order, using the right hand, and repeated using the left hand. If the person being tested is left-hand dominant, that hand is tested first.

The board is then placed vertically, with the center at shoulder height and in line with the midline of the body. The person being tested stands approximately 12 inches (33 cm) from the board. The board is placed horizontally on a table and the test repeated with the subject standing at the lower edge of the board.

Scoring

Each attempt is scored separately for each square. An average score for each hand in vertical and horizontal position is calculated by dividing by the scalar 16.

Hand-to-Hand Coordination

In the born blind this capacity is almost entirely kinesthetic, influenced only by ear coordinative factors. In the newly blind or adult blinded person visual memory and its interaction on the kinesthetic memory play an important role.

Administration

In this test a magnetic block is placed in square A and a second block in the center square. The subject is blindfolded as in the kinesthetic ability test. His left hand is placed on the block in square A and his right hand on the other block. He must transpose the position of the blocks. The score is read in both areas and averaged. The blocks are then centered, and using the hands in the opposite directions, i.e., the left hand at the center and the right hand in square A the transposition is repeated. Score as before.

Scoring is done as in the kinesthetic ability test, but in each attempt an average of two positions is determined. The test is repeated through the full range of movements from A to H. The total score is divided by 16 to obtain the rating.

Note. No trial runs are given with this test.

Evaluation

This test covers a limited range of movements and is restricted to the upper limbs and to a lesser extent the torso.

A considerable amount of research is needed to develop more sophisticated tests to cover the entire range of body movements. Until this test becomes one of many, problems of mobility, hand-foot coordination, and many other factors will continue to be intuitively assessed. This kinesthetic test is, therefore, only a start on the problem of assessing kinesthetic ability.

As this test has been developed to assess adult workers, its use with young children is not recommended, due to the reach required. The distance the subject stands from the board may present a problem, as variation in reach may effect results at the periphery. Any

WATSON-MURRAY KINESTHETIC ABILITY TEST

State Dominant Hand:

Score Sheet

	A	B	C	D	E	F	G	H	Total	Average	Remarks
R/H Vert.											
L/H Vert.											
R/H Horz.											
L/H Horz.											

TWO-HAND COORDINATION TEST

	A	B	C	D	E	F	G	H	Total	Average
1.										
2.										

Evaluation: . . . .

Recommendation:. . . . .

difficulties in this direction should be noted on the scoresheet.

It would be appreciated if others using this test send us the results to assist in compiling norms and statistics. As the correlations of test results and performance become available we will be able to furnish more data on the application of this test to the problem of placement. As there are many factors related to the higher intergrative processes of this sensory factor which are not properly understood, it may be necessary to revise or modify the present method of testing.

Placements made since the application of this test show a marked correlation between the kinesthetic function in the work situation and test results. Job analysis showing these results may be obtained on request.

Mobility

When considering the placement of a blind person his degree of mobility plays an important part. Certain aspects must be considered.

Mobility Indoors in Familiar Surroundings. This must of necessity be at a high level of skill if the client is to be placed in a work situation in a factory or, for that matter, anywhere on the open labor market. It is inconceivable that a worker should have to depend on an escort for the simplest mobility needs at his place of work. The only exception to this is an environment where there is considerable movement of trucks and the like.

Mobility Outdoors in Familiar Surroundings. Should the worker's ability to familiarize himself with new outdoor routes be high, then few problems will be experienced by him in traveling to and from work. An escort would be required initially.

Mobility in Unfamiliar Surroundings. If this is poor, and the client lacks confidence in learning new routes, then escort facilities may have to be arranged. This would mean, however, that the worker would be dependent for all time on the good will of others. This applies equally to mobility both indoors and outdoors.

With the advent of guide dogs and the long cane technique the problems of mobility retraining, where necessary, are not insurmountable. It must always be borne in mind that the blind person's ability to integrate into society depends on his ability to move in society. Mobility may almost be said to be synonymous with independence, and the person seeking economic independence should seek independence of movement.

Finger Dexterity

After experimenting with a number of tests, which proved to be unsuitable, the following test was designed in 1969.

The test set is composed of a vertical board 6 by 4-1/2 inches and 3/32 inches thick, placed vertically and at right angles to the center of a base, 12 by 8 inches and 1 inch thick. A cover plate 3 inches wide by 14 inches long extends from the front of the base and over the board. Enough room is allowed for the fingers to reach the board without being hampered by the plate. Two recesses are made in the base 2-1/4 inches in diameter by 3/8 inch deep near the back of the base and on either side of the board. A number of 1/8- by 3/16-inch screws are placed in the right hand recess; in the left recess, an equal number of nuts is placed.

KINESTHETIC ABILITY TEST - SCORES EXPRESSED IN AVERAGES

Score	Average	Score	Average
8	0.5	37	2.3
9	0.5	38	2.3
10	0.6	39	2.4
11	0.6	40	2.5
12	0.7	41	2.5
13	0.8	42	2.6
14	0.0	43	2.7
15	0.9	44	2.7
16	1.0	45	2.8
17	1.0	46	2.9
18	1.1	47	2.9
19	1.1	48	3.0
20	1.2	49	3.0
21	1.3	50	3.1
22	1.3	51	3.1
23	1.4	52	3.2
24	1.5	53	3.3
25	1.5	54	3.3
26	1.6	55	3.4
27	1.7	56	3.5
28	1.7	57	3.5
29	1.8	58	3.6
30	1.0	59	3.7
31	1.9	60	3.7
32	2.0	61	3.8
33	2.0	62	3.9
34	2.1	63	3.9
35	2.1	64	4.0
36	2.2		

The board has 6 rows of 10 holes 3/16 inch in diameter, spaced one half inch apart. The client sits in front of the board and is given an opportunity to fit two nuts and screws in place. These are then removed and he is given two attempts of four minutes each to fill as many holes as possible starting from the top back hole and working towards himself (Figure 3).

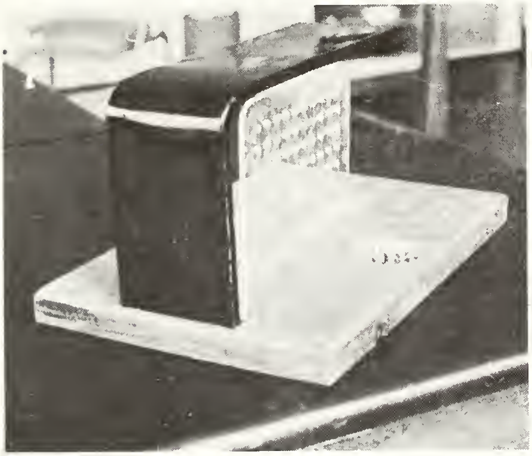

Figure 3. Finger Dexterity Test

Scoring

One point is awarded for each screw fitted, one for each nut, and one point for each pair in sequence. A point is lost each time the sequence is broken.

Rating	Score
1	under 30
2	30 to 45
3	46 to 70
4	over 71

Note that the visual factor is removed from this test by the cover plate, removing hand-eye coordinative factors when testing the sighted and partially sighted. The test is, therefore, a true reflection of dexterity and not other capacities. In addition to its use for the blind and partially sighted, this test should be of benefit to testers wishing to assess this capacity in sighted workers having to work in confined spaces where the visual factor is limited, i.e. office machine technicians. Finger dexterity plays an important part in fine assembly work, certain fields of packing, and many other work situations using small components. Placements based on this test to date show a very high correlation between test results and work performance. A considerable amount of research and experimentation is still needed to evaluate this test fully, but results thus far more than justify its use.

Work Tolerance

This may be defined as the ability of a worker to maintain a sustained effort in the work situation. Tolerance may be subdivided into tolerance to physical efforts and tolerance to psychological or mental effort or stress. The latter is discussed under "psychological factors," and needs no comment at this stage.

Physical Tolerance

This must be related to the demand level of the work situation, taking due cognizance of the physical effort required. Thus postural tolerance includes standing or sitting for long periods. The previous work record of an institutionalized worker will usually give this data. Failing this, a trial period or test situation can usually be arranged. This trial should be based on normal working shifts for at least two working weeks. Should there be any physical impairment present or a history of debilitating disease, a medical report is essential before placing a worker in a situation which makes heavy physical demands on him.

Mechanical Aptitude

The NIPR Tripod Test is used to determine mechanical aptitude. The test is as used for sighted clients, except that an additional tripod is erected and the client allowed to feel it for a specified time. No time allowances are made for the blind and partially sighted.

Rating	Score
4	18 to 21
3	14 to 17
2	11 to 13
1	0 to 10

This test seems to have a high correlation with intelligence and mechanical aptitude, and has proved to be one of the most significant tests adopted.

Learning ability is also clearly revealed by an improvement in scores over three attempts. (This test is supplied by the NIPR and permission must be obtained for its use. As in the case of all tests permission is granted to the tester and not to the organization to which he belongs.)

Personal Appearance and Mannerisms

A careful note should be taken of the personal appearance of the client, and the following factors noted: cleanliness of person and clothing, including grooming; clothes may be worn or old, but should be mended and pressed. Many blind persons have unfortunate mannerisms associated with the impairment; these may include lack of facial mobility, grimacing, ear tugging, rigid posture, or others which can irritate sighted persons. Mannerisms should have been corrected as far as possible during rehabilitation or education.

Conclusion

The ratings obtained are now to be related to the demand levels of a specific work situation. It must be remembered that there is no formula which can be given for all work situations. Each one must be taken in relation to the specific demand level of the job.

The determination of the demand level of work situation will be dealt with in subsequent sections on job analysis and work evaluation. The data contained in this section is based on methods adopted in the testing of over 250 persons; 120 have been placed in permanent employment on the open labor market since January 1968, the retrenchment level being between 6 and 8 percent. This seems to indicate the value of accurate capacity assessment in relation to demand levels.

The next section will be devoted to determining these demand levels, and includes the integration of the worker into the work situation, in other words, the actual placement of the blind person.

JOB ANALYSIS OR WORK STUDY

Having discussed the need for assessment and placement of the client, we can now proceed to discuss the evaluation of the work situation. This evaluation is a prerequisite to placement and no placement can be made without it.

Demand

Each work situation makes certain demands on a worker. They may be defined as the sum total of abilities, aptitudes, and attitudes which must be possessed by the worker to perform successfully the task set for him. It is the function of the placement officer to undertake a complete job analysis of the work situation, and to determine the demand level of a job. The demand levels must be evaluated in terms of the capacity of the worker to be placed. It is pointless, for example, to place a blind person with poor kinesthetic ability in a work situation which demands accurate and precise movements.

Although we will discuss various aspects of job analysis, and give a detailed example of one, there is no do-it-yourself kit for this purpose and experience is the best teacher. At this stage we must once again caution placement officers and others interested in the problem that mistakes made in evaluation can only work to the detriment of the client. Too high a demand on the client can lead to frustration and accident. Too low a demand can lead to boredom and loss of concentration, which in turn can again cause an accident. Stopwatch comparisons can give a very good indication of the client's ability in the trial period if due allowances are made for the learning period.

Each work situation should be evaluated individually, for although on the surface two work situations may be similar, there could be significant differences in physiological or psychological demands from one factory to another.

The Preliminary Survey

Name, address, and telephone number of the firm, both site and postal, should be recorded. A record should be kept of the officials in the firm with whom one is dealing. The names of officials must be accurately recorded along with their correct designation.

Environmental Survey

Transport. The availability and nature of transport must be investigated to ensure that the client can reach his work regularly and punctually.

Access. Access to the work situation should be noted and arrangements made, where necessary, to arrange escorts for blind clients. This aspect of the survey is even more important to placement officers dealing with paraplegics.

Lighting. The lighting level of the work situation is extremely important when partially sighted workers are involved. A peculiar anomaly exists, however, whenever clients suffering from photophobia are concerned; in this case poor lighting can be an asset.

Ambient Noise Level. Although there are instruments available which can measure this factor, they are both costly and not freely available to placement officers. Experience, however, soon enables a placement officer to judge at what level it becomes dangerous to place a blind person. In a static work situation and environment this noise level can be fairly high. On the other hand, in an environment where there is movement of fork-lift trucks, etc., the noise level must be low enough to allow the worker to hear movement and take any necessary action to ensure his safety.

Housekeeping and Safety Consciousness. Poor housekeeping, or an untidy and cluttered environment, can create hazards to all workers especially so to blind workers. Adequate safeguards on equipment drive belts, etc., are essential. It is advisable for all placement officers to undertake a recognized course in occupational safety to help them make accurate assessments of this factor.

Ventilation. The adequacy of ventilation must be noted. Dust-laden atmosphere and poorly ventilated surroundings can lead to unnatural fatigue and proneness to accident.

Ambient Temperature. This factor is also important, as too high or too low a temperature can affect work tolerance and performance.

Analyzing the Specific Work Situation

Description of Job. A short description of the job is given, i.e. Eccentric Press Operator.

Equipment or Tools Used. A full and detailed description of equipment and tools used to perform the work is given, with special reference to visual factors such as dials, gauges, etc. This information is needed if modifications are to be undertaken.

Detailed Job Analysis. The job analyzed must be described in fullest possible detail giving motions required to perform the work efficiently. This does not mean that the existing method of doing the job should be recorded, as this may not be practical for the blind or necessarily the most efficient method. When this analysis has been completed an evaluation is made.

Job Evaluation

Work Tolerance. (To sustained physical effort.) This must be rated for severity of demand on the worker, and should be related to the actual muscular effort expended.

Posture Tolerance. Continually maintaining one posture can cause considerable physical stress, and can affect the performance level of a worker, particularly if the posture is unnatural such as a stooping position. Physical incapacity may preclude some workers from adopting certain postures. A comfortable sitting posture would be given a demand level of one, whereas an unnatural posture (standing on one leg with the other leg depressing a pedal, while the worker leans over his work) would have an extremely high posture demand.

Tolerance to Repetitive Work. This form of tolerance is psychological rather than physical, and is far greater among persons of lower than average intelligence than among the highly intelligent. This can create special problems, as intelligent application of capacity may go hand in hand with tolerance to repetition, such as the operation of machines in which the work may be repetitive, but adjustments have to be made to the procedure to compensate for variations of temperature, quality of material, etc.

Noise Tolerance. The tolerance to noise may be particularly significant as far as machine operators are concerned, for while the ambient noise level may not be excessive, the continuous noise of a machine may be irritating to an extent that a worker may not be able to tolerate the stress so caused.

Miscellaneous. Tolerance factors which preclude persons suffering from specific impairments from the work situation (a worker with a prosthesis such as a pylon would be unable to stand for prolonged periods) should be noted.

Sensory Requirements

Sight. (Visual Capacity) The degree of sight, if any required, must be noted.

Auditory Capacity. Details of hearing requirements must be noted, including directional, depth perception, acuity, etc.

Tactile Perception. The demand, if any, for texture discrimination, temperature discrimination, wet-dry discrimination, etc., must be evaluated and noted.

Starognosis. The ability to determine shape or identify an object or its position with the palm of the hand, without involving the fingers, is required in some jobs (e.g., assembly of drain traps).

Smell. Occasionally a worker requires an acute sense of smell, as to detect free liquid propane gas, for example. This factor has not as yet played a part in the demand level of a work situation and can reasonably be ignored.

Kinesthetic Ability. This factor plays a very important role in most work situations, and it is essential to note the precision of movement required by the worker to perform the task. In the case of press operators, for example, an error in movement of a centimeter or so can cost the worker a finger. It must be borne in mind that in the case of the blind kinesthesis is the substitute for hand-eye coordination.

Coordinative Factors

Gross Dexterity. This involves total hand movements, and is used in many assembly jobs, operating nutting machines, etc.

Finger or Fine Dexterity. Fine dexterity involves precise accurate finger movements and coordination, i.e. assembling springs for oil seals.

Hand-eye Coordinative Factors. These factors are relevant for both sighted and partially sighted workers. Care must be taken to ensure that this factor is essential, for it can often be satisfied by hand-ear coordinative factors, or by kinesthetic ability and memory. On conveyor belt systems, for example, the installation of an industrial sensor for the blind can enable blind workers to substitute hand-ear coordination for hand-eye coordination.

Hand-ear Coordination. This factor is often used as a substitute for hand-eye coordinated movements, particularly in machine operating.

Hand-to-hand Coordination. This is an important factor demanded by most industrial jobs. The level of the demand varies considerably, for example it is extremely high in battery wrapping, and fairly low in operating a sander.

Hand-foot Coordination. This demand is found in many work situations, i.e., operating a treadle press.

Mobility. This demand is not often high in the work situation as such because most blind workers stay put, but it does play an important role in the independence level of all workers. This is particularly true concerning getting to and from work, canteens, and toilet facilities.

Psychological and Educational Demands

Ability to Make Decisions. As we mentioned in the section dealing with assessment of the worker, this factor influences all work situations and must be carefully evaluated. Care should be taken not to under or overestimate the importance of this factor.

Initiative. This factor is closely related to the ability to make decisions and to act independently of others. It is usually very low in demand level in most industrial tasks of a repetitive nature, and rises with the decision making level of a job.

Interpersonal Relationships. Wherever a worker works with others, this factor is important, and the demand level rises with the number of workers in the same work situation. Ignoring this factor can lead to chaos in a factory.

Leadership. This factor is related to all the foregoing factors interacting upon one another, and the higher one goes on the employment scale, the more important it becomes, and the higher the demand level rises.

Teamwork. The closer the worker has to work with others, the greater this demand becomes.

Level of Education. This is often specified by the employer and usually the demand rises with the ability to make decisions, etc.

Special Training. Any demand for pretraining or inservice training should be noted.

Promotional Possibilities. The opportunity for promotion which a job offers can play an important part in the job satisfaction of a worker, particularly for those whose capacity is equal to a higher demand level than his original placement.

General

Hours of Work. The hours a worker must work should be noted, since long hours may influence tolerance factors.

Rate of Pay. This is usually related to the overall demand level of the job. Incremental opportunities should also be noted.

Medical Aid. This is an incentive, but should be noted. Any other benefits should also be noted.

Production Norms. The demand level of this factor varies from job to job, and has a strong bearing on the total demand level.

Quality Demands. Again, this is a variable factor, which influences the total demand level.

Special Modification of Equipment

Full details must be given of any modifications necessary to allow the worker to do his job. For example, the installation of jigs may enable a blind worker to operate a drill press.

Recommendation. This may include a specific worker or a group, for example, former brush-makers.

A SAMPLE JOB ANALYSIS

John Smith & Co., Phone: 7575
10 Tenth Street, Box 145,
Klip Dorp. Klip Dorp.

Nature of industry: Measuring equipment and level manufacturers.

Name of official contacted: Mr. H. R. Jones, General Manager.

Referred to: Mr. J. Brown, Works Manager.

Environmental Survey

Transport: Bus and train service, good at peak hours. Train service only for night shift; station 1-1/2 miles from work. Bus stop one block from work.

Access: Approach to factory poor at present due to construction work.

Lighting: Very good; natural and fluorescent. Suitable for partially sighted workers. Too bright for those suffering from photophobia.

Ambient noise level: Moderate and within safe levels.

Housekeeping and safety consciousness: Good, but barrier lines not painted.

Ventilation: Very good.

Ambient temperature: Hot in summer, very cold in winter.

Specific Work Situation

Description of job: Assembly of steep tapes.

Equipment or tools used: Geared winding jib. Retaining thimble. Pneumatic screwdriver and retaining jib. Storage racks for tapes and springs. Storage bins for cases, retaining plates and screws.

(At this point a sketch of jigs and tools would appear along with a plan showing the location of equipment racks and bins in relation to one another.)

Detailed Job Analysis

The worker is seated at a bench in front of the winding jig. Right hand moves lower half of case from Bin No. 3 and places it in winding jig. A retaining plate is dropped over the pin (dimples down) with the right hand (Bin 1). Left hand removes spring from rack and inserts it into slot in center pin of case after bending end over in an anticlockwise direction. This bend is made with the thumb and forefinger of the right hand.

The spring is then retained between the thumb and forefinger of the left hand, keeping the free end above case level. A cloth is held around the spring to protect the fingers. As the cloth is oil impregnated, it also provides lubrication. The index finger of the left hand is held on the retaining thimble, which is placed over the center pin and spring. The right hand turns the winding handle of the winding jig in a clockwise direction, while the spring is guided with the left hand.

Note. The spring winds in an anticlockwise direction. Care must be taken not to wind the spring too far and to keep an even tension on it with the left hand. Care must also be taken not to allow the spring to foul the case.

When approximately 8 inches of the spring is not wound, the operator places the spring through the slot of the case and retains it there with the left hand. The right hand is placed on a retaining plate, dimple side up, which fits the top half of the cover taken from Bin 2. The case is them removed from the jig with the right hand, the spring retained in its protruding position with the thumb and forefinger of the right hand while holding the case together with the remaining fingers and palm of the right hand. With the left hand the operator picks up a tape from the rack and inserts the slotted end of the spring into the tape from the underside. The tape is held concave side up. The spring is slotted on both sides while the tape is slotted in the center. The tape and spring are now fed into the case with the left hand while the halves of the case are held together with the right hand. The case is then placed in the retaining jig of the pneumatic screwdriver with the right hand, and a screw dropped through the upper part of the case into the hole in the center pin with the left hand. The screwdriver is then brought down with the right hand until the screw is tight. The screwdriver stops when the screw is tight, and the completion of this operation is heard clearly by the operator. The completed tape is removed from the jig and placed in the bin provided for packing and dispatch.

Job Evaluation

Work Tolerance. Tolerance to sustained physical effort: low. Posture tolerance sitting: A moderate tolerance to this position is required. Tolerance to repetitive work: High. Noise tolerance: Moderate.

Sensory Requirements. Visual acuity: Nil. Auditory acuity: Good. Hand-Ear coordination and other hearing factors: not demanded. Tactile perception: Moderate. Sterognosis: This plays some part in the assembly of the tapes. Smell: Not demanded.

Coordinative Factors. Gross dexterity: Moderate. Fine dexterity: Exceptionally high. Hand-Eye co-ordination: Not essential. Hand-Ear coordination: Fairly high. Hand-to-Hand coordination: Exceptionally high. Hand-Foot coordination: Not required. Mobility: Not important to the job.

Psychological and Educational Demands. Ability to make decisions: Moderate. Initiative: Moderate. Interpersonal relations: Good. Leadership: Not required. Demand of teamwork: Worker works on own. Level of education: Std. 6 would be adequate. Special training requirements: In-service. Promotional possibilities: Very limited.

General. Hours of work: 46 hours per week. Rate of pay: R7.50. Medical aid: None. Pension: None. Production norm: 2-1/2 minutes per unit. Quality demand: High. Special modifications: None required, except that the retaining jig under the screwdriver should be secured. Recommendation: A worker from the wire drawn brush section with a Std. 6 education should be assessed for this situation.

Conclusion

Having done a job analysis it can be readily seen how the capacity of a worker can be linked to the demand level of the work situation. It must be stressed that no matter what the job may be there is no short-cut method which can be adopted. The higher the demand level of the job, the more important the analysis becomes; and the more complex, the more attention must be given to psychological factors. Remember that mistakes made by the placement officer in analyzing a job can cause untold harm to the client. In fact, the placement officer's first mistake in the industrial field could well be the client's last.

Modification of Equipment

As we have already mentioned, the elimination of the visual factor may be necessary to enable the blind worker to function efficiently and safely.

It is a common practice in industry to use jigs which hold the job in place and guide the drill in repetitive drill press operations. This principle is one which has been successfully adapted to enable blind workers not only to operate drill presses, but to perform many other jobs of a repetitive nature. (An example: jigs were made to enable blind workers to staple plastic bags in a predetermined position on a card.) Jigs have also been devised for partition assembly, sheet metal work, and many other jobs. Guides and stops have also been successfully used to enable blind workers to operate benders and perform such complex tasks as lead moulding.

Most factories have tool makers or other technical staff who are only too pleased to undertake the modification of equipment, provided such modification is not too costly and has the approval of management. Usually the modification required is relatively simple and can be installed both economically and easily.

In a number of jobs modification to equipment has speeded up the work to such an extent that employers have adopted the method for sighted workers. An example: plastic strapping was being cut to length and inserted into slots in washers; by simply cutting the strap at an angle of more than a 50 percent, an increase was obtained in output whether the worker was blind or sighted. This method has been adopted by the factory with great savings. Another example of a simple guide fitted to a bending machine enabled a blind operator to line up pipe against a stop so much more readily than using the standard method that the time it took him to perform the whole operation was reduced from 45 to 30 seconds.

Although many of these modifications could be described in detail, it would be of little value, as a modification is often unique to a particular situation and to the capacity of a particular worker. Modification of equipment also plays an important part for other disabled persons; for example, hand controls for paraplegics on presses rather than the usual foot control. Volumes could be written on this subject, but it is sufficient to say that with some technical knowledge, a bit of imagination, and some experimentation most problems can be solved.

SOCIAL IMPLICATIONS

The Social and Domestic Situation of the blind Worker

It must be recognized that the average person spends not more than 46 hours out of a total of 168 hours a week in his working environment. It is necessary, therefore, to ensure that provision is made to enable him to live a normal social life outside of working hours. This presents special problems in the case of the Bantu, as he usually has to live long distances away from his work and is often away from his family.

Unless the worker has a very high mobility rating, it is essential that adequate arrangements are made for his transport to and from work by reliable escort. He should also be completely self-reliant in his domestic situation, and should be able to cope with the problems of activities of daily living. He should, for example, be able to cook for himself, to sew on a button, or to change a tap washer.

If he has any church affiliation, arrangements should be made to put the worker in touch with his local congregation.

Should the worker be placed in a new or unfamiliar district, it is desirable that he find his way to shops, etc., and that he be introduced to someone in the community with whom he has something in common other than his blindness. The social worker is often able to help in this direction.

The family unit should be kept together whenever possible. This is often impossible in the case of the blind Bantu, as he is subject to influx control and residential qualification regulations. In such cases, arrangements should be made to ensure that he is at least able to visit his family periodically, and that someone is able to assist him with his correspondence to his home. This aspect of the placement of the Bantu worker can be most difficult, for if the family has to be separated there is always the danger of a complete breakdown in family life, with the usual disastrous consequences.

To summarize, then, it must be borne in mind at all times that man is not merely a working animal; he is also a social and worshipping creature. To ignore this fact, is to deny him the right to a normal, balanced, and meaningful existence: this, in turn, is a denial of his humanity.

Placement

Having discussed the assessment of the client and methods of evaluating the work situation, we must also discuss some aspects of placement itself, for this is the end point of all our endeavors. The worker spends nearly one-third of his productive life at work, and unless he can find acceptance and fulfillment there he is unlikely to be happy either at work or at home. In other words, unless there is job satisfaction no placement is successful.

What are the criteria for job satisfaction? The primary condition is, I feel, acceptance. The worker must feel that he holds his job on merit and not out of sympathy. The employer and his fellow workers must be convinced that the worker should be treated just as other workers, within the limits of his impairment. He must be expected to compete with his fellow workers, and to maintain the same hours they do. He must be subject to the same factory discipline. Unless these conditions are strictly adhered to, the worker will feel that he is not accepted as normal, and there will be a tendency on the part of other workers to reject him when they feel he is being shown favoritism.

Second, assistance should only be given the worker when absolutely essential, as when guiding him through hazardous work areas. The employer must be prepared to accept the worker, on the same terms as other workers doing the same job, as far as pay is concerned.

As the critical period is the first two weeks, it is essential the worker's integration into the factory be carefully supervised during this period. In-service training should also be supervised by the placement officer during this period normally considered as probationary.

After Care

The worker's progress should be followed up for at least a year after placement to ensure that both employer and employee are happy with the placement; and to check on work habits, productivity, safety, and other factors which may affect his or other placements.

A specimen of the form which is completed after placement follows.

PLACEMENT FORM

Date of Placement . . . .
Name of Employer. . . . .
Address . . . .
Nature of Industry or Organization. . . . .
Immediate Superior or Person to be Contacted. . . . .
Phone . . . .
Capacity in which Employed. . . . .
Description of Work Situation . . . .
Comments on Ability to Learn Job. . . . .
After Care Visits:

Date	Comments
1 thru 6	. . . .

Placed by . . . .
Capacity. . . . .
After Care Visits By. . . . .
Capacity. . . . .
Rate of Pay . . . .
Increments . . . . / . . . .
Retrenchment Date . . . . Reason. . . . .

If re-employed complete new placement form.

Acknowledgments

My since appreciation must go to Mr. A. J. Murray, originally one of my placements, for his help and encouragement and at times prodding; to Mrs. du Toit of the Occupational Therapy College, Pretoria, and to her staff for their unfailing assistance and encouragement; to the Chairman and Committees of the S.A.N.C.B. for their encouragement and facilities.

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Editor's Note: Through an oversight of the Editor, a penultimate and not the final version of Dr. Foulke's paper, *The Perceptual Basis for Mobility*, was published in our last issue. Some corrections and some emendations of the text were supplied to me by Dr. Foulke, and I am pleased to have this opportunity to bring them to the attention of the readers.

Leslie L. Clark

THE PERCEPTUAL BASIS FOR MOBILITY

Emerson Foulke

Errata

Page 2, column 1, lines 35-40 should read:

He may even obtain information about the distance and direction of more distant objects by using an electronic device, such as the Kay Sonic Aid (Kay, 1963), which was used for a time by a few blind pedestrians.

Page 2, column 1, lines 52-58 should read:

In contrast, it is, for the most part, only by physical contact that the blind pedestrian is directly informed about those features of objects in the environment, such as size, shape, texture, and rigidity. This knowledge is of basic importance to successful mobility.

Page 2, column 2, lines 6-12 should read:

Of course, when the shapes have been learned through a process of associative learning, characteristic sounds or smells may serve to identify them. However, if the blind pedestrian lacks relevant associative learning, he will not be directly informed about the space he will occupy with each succeeding step, until he moves into it, and the information he obtains about a space by occupying it may come too late to enter into course decisions.

Page 2, column 2, line 48 add:

It is to be pointed out here, that the cane when properly managed is not liable to all but the last of these criticisms.

Page 3, column 1, lines 26-35 should read:

If the sector of the environment with which he is concerned is really novel, he must negotiate it many times before he can organize the accurate and detailed schema he needs to traverse his path with comfort, speed, grace, and safety. Even when the blind pedestrian has mastered a sector of the environment, the schema representing the terrain in which he is interested will be an impoverished one,

Page 3, column 1, line 50 add:

Of course, as will be discussed later, the problem posed by novel situations is ameliorated by the ability of the blind pedestrian to make use of environmental redundancy.

Page 4, column 1, lines 50-62 should read:

There may have been some auditory stimulation from which he could have obtained the information that he was abreast of the filling station, or he might have maintained a straight course by listening to the flow of traffic in the street at his left and following a path parallel to its flow; but, let us suppose that on this occasion, the flow of traffic was light and that informative sounds in the environment were masked by the insistent chatter of a pneumatic drill that is being employed in street repair. However, because he has made the mistake of deviating to the right on an earlier occasion, he now analyzes the situation, and knows what corrections to make.

Page 6, column 1, lines 30-33 should read:

At present, Kay's ultrasonic spectacles (Kay 1970), are the most promising artificial environmental sensor.

Page 6, column 1, lines 41-42 should read:

Though this device is still under evaluation and not yet available,

Page 6, column 1, lines 59-62 and column 2, lines 1-2 should read as follows, with the accompanying addition:

If the blind pedestrian had no stored information to use in charting his course, so that he had to depend only upon what the clear path indicator could tell him, he would be destined to wander, safely but aimlessly, through an unstructured environment. Of course, in conjunction with stored information, the information provided by a clearpath indicator is quite valuable.

Page 6, column 2, lines 35-38 should read:

Yet, with the conspicuous exception of the cane, none of the mobility devices now available can give him much of this information.

PROCESSING OPTICAL CHARACTER RECOGNITION (OCR) OUTPUT INTO INPUT FOR BRAILLE TRANSLATION

Robert L. Haynes
Data Processing Manager
American Printing House for the Blind
Louisville, Kentucky

In June, 1970, the American Printing House for the Blind (APH) agreed to investigate the feasibility of Optical Character Recognition (OCR) as a means of producing input for a braille translation system. The first book to be published as a result of this project is *The Unsubstantial Castle* by Robert Rushmore.

Conferences were held with two OCR companies in which text reading was discussed in detail. Dissly Systems in Easton, Pa. was willing to scan the inkprint copy of *The Unsubstantial Castle*. The other company declined to participate. Dissly furnished a tape that was not error free but was a reasonable representation of the inkprint copy. The cost of the Dissly tape was somewhat higher than the APH cost of keypunching and verifying.

The APH is appreciative of the interest and cooperation shown by Dissly Systems in making this project possible.

The following report describes the detailed procedure for converting scanner output to translation input.

PROCEDURE

The 9-track output tape was copied to 7 track. Since the size of the character set exceeded the capacity of 6-bit representation, the 8-bit characters of the 9-track tape were converted to 12-bit characters on the 7-track tape.

The text was scanned to identify all the characters used and to determine the significance of each by locating the first occurrence of each. Besides numerals and upper and lower case alphabetic characters, 19 special characters were used in the text.

A run was made to change the tape record format. Numbers indicating the line number of the inkprint page were removed.

1. Page number records were deleted and page number was inserted into a fixed field in each record. Numbers were adjusted to correspond as closely as possible to the inkprint page numbers. Because of the blank pages in the inkprint text, numbers on the scanner output tape varied from 2 to 7 pages from the inkprint copy.

2. On the scanner output tape, special format features such as indentation or centering were indicated by an asterisk at the beginning of the record. Since the special feature in the majority of cases was a new paragraph, the paragraph symbol was inserted at these points.

3. The text was put into records having 72 characters.

4. Hyphens marking word division at the end of the inkprint line were removed in this run. The scanner output used a different character to represent the hyphen of a compound word at the end of a line. These hyphens were retained.

Text data was converted as far as possible to the symbols used in braille translation input. For example,

colon	to	#.
question mark	to	$Q
A	to	#A
b	to	B

Processing up to this point was primarily done by the computer with a minimum of human intervention.

Further work was done primarily of an editorial nature but using the computer a considerable amount to locate and print out various text features and to rewrite the text incorporating the editorial changes.

In the scanner output, fully capitalized words or word series were enclosed by asterisks. These words were located. In this particular book, most of these words needed to be changed to lower case. (14 changes)

Italicized words or word series were enclosed by percent signs in the scanner output. These words were listed in context so that appropriate single of double italics signs could be inserted. Some of these words also required Grade 1 symbols. (141 changes)

Ellipses, spaced periods in the scanner output, were examined to determine use of ellipsis only, ellipsis preceded by period, or ellipsis followed by period. (59 changes)

Dashes were checked for spacing between the dash and the word following. (26 changes)

Chapter and section headings were located and symbols were inserted to control chapter and heading titles. (30 changes)

Hyphenated words were noted and the $H (non-line-ending hyphen) symbol was inserted where required as in stammered words. (50 changes)

Format symbols for features such as poetry lines and blank lines, obvious on the printed page but not indicated in the scanner output, were inserted. (9 changes)

Need for a few changes such as letter sign was discovered inadvertently. (3 changes)

In the process of making editorial changes a number of scanning errors or omissions were noticed.

Corrections were made for these errors. (78 changes)

p 4	ln 22	Sheridan, a	space between words omitted
p 10	ln 29	cry	for cry.
p 13	ln 1	Two	special format of chapter title not indicated
p 20	ln 28	"Auratum	right quotes for left quotes
p 20	ln 28	platyphytllum	for platyphyllum

p 27	ln 18	»Oh?«	for «Oh?»
p 29	ln 23	Francis--"«	for Francis--"
p 34	ln 27	the pain	space between words omitted
p 35	ln 12	Nothin	for Nothing
p 37	ln 1	Three	special format of chapter title not indicated
p 38	ln 12	possible---while	for possible--while
p 39	ln 21	"I-I	wrong hyphen at end of line
p 39	ln 22	didn't--	for didn't--"
p 43	ln 13	No	not placed in italics
p 49	ln 1	réclame	accent not indicated
p 51	ln 25	'A	apostrophe instead of left single quote
p 51	ln 25	skin,'	apostrophe instead of right single quote
p 51	ln 26	'It'll	apostrophe instead of left single quote
p 51	ln 26	somewhere.'"	apostrophe instead of right single quote
p 51	ln 26	somewhere.'" But	extra space between words
p 52	ln 27	. . . those	extra space between ellipsis and word
p 53	ln 2	Francis	for Francis.
p 53	ln 3	"Yes.	special format of beginning of paragraph not indicated
p 54	ln 17	I	not palced in italics
p 55	ln 30	fills	for filles
p 62	ln 17	cied	for cried
p 69	ln 14	bizrre	for bizarre
p 74	ln 2	I	not placed in italics
p 75	ln 15	men."	left quotes for right quotes
p 78	ln 23	hard,.	for hard,
p 81	ln 1	Four	special format of chapter title not indicated
p 94	ln 6	sir?"	left quotes for right quotes
p 96	ln 15	hungry-	for hungry."
p 98	ln 5	horse?"	left quotes for right quotes
p 99	ln 2	pâté	accents not indicated
p 99	ln 3	pétillant	accent not indicated
p 99	ln 3	Neuchâtel	accent not indicated
p 103	ln 30	just	for Just
p 104	ln 24	. . .	for . . ."
p 110	ln 29	sarcastically, "What	space between words omitted
p 113	ln 28	affectionate, if	space between words omitted
p 114	ln 9	knocks. He	space between words omitted
p 116	ln 6	Rhy-Jones's	for Rhys-Jones's
p 119	ln 21	I	not placed in italics
p 119	ln 31	I	not placed in italics
p 120	ln 24	"He	right quotes for left quotes
p 122	ln 2	wish	not placed in italics
p 123	ln 1	Six	special format of chapter title not indicated
p 124	ln 1	Rhy-Jones	for Rhys-Jones
p 132	ln 25	giv-- ing	for giving
p 135	ln 15	Musical?'	for Musical?"
p 135	ln 21	uncle."	left quotes for right quotes
p 144	ln 20	Requiem	not placed in italics
p 145	ln 27	"Killed---?"	for "Killed--?"
p 148	ln 19	too--"	left quotes for right quotes
p 149	ln 6	couple, attractive	space between words omitted
p 152	ln 26	pride	not placed in italics
p 156	ln 1	Seven	special format of chapter title not indicated
p 161	ln 3	I	not placed in italics
p 163	ln 22	scene, guilty	space between words omitted
p 165	ln 26	Francis walked	special format of beginning of paragraph not indicated
p 166	ln 29	cro-- quet	for croquet
p 168	ln 3	two	not placed in italics

p 175	ln 16	die."	left quotes for right quotes
p 178	ln 22	hands	not placed in italics
p 182	ln 15	they've---they've	for they've--they've
p 187	ln 7	"Hey!""	left quote annexed to right quote
p 187	ln 15	in,"	left quote for right quote
p 193	ln 1	Eight	special format of chapter title not indicated
p 196	ln 18	you---"	for you--"
p 200	ln 4	bigger."	left quote for right quote
p 200	ln 12	voice,asking	space between words omitted
p 201	ln 31	how---?"	for how--?"
p 203	ln 7	Sherriden/ speeking	for Sherriden/speeking
p 203	ln 8	go /away	for go/away
p 204	ln 21	you	not placed in italics
p 207	ln 10	"Long	right quotes for left quotes
p 207	ln 17	William?"	left quotes for right quotes

Computer processing time was 5.5 hours. This does not include time for compilation and testing of programs or for punching cards from tape.

Cards punched from the tape were keyverified. An additional 150 text errors were discovered in this process.

Editor's Note: As the reader may infer from the above details, the prospect of using optical character recognition techniques as a method of generating input to an automatic braille transcription process is not encouraging. Optical character recognition (OCR) systems that can "read" a large number of differing fonts, and can cope with variable pitch printing, tend to be very expensive. And the output from the best of such systems yields text which is only 92 to 99 percent correct. For many purposes, a one percent error rate due to machine faults may well be acceptable; but as an input to an automatic braille transcription scheme, this error rate is so high that it would be better to prepare input in other ways. Note that the errors encountered, and tabulated, in the above report were left after a thorough proofreading by the OCR device's manufacturer.

It would seem clear, from this one instance at least, that the future of OCR systems in making input for braille transcription systems would depend on the further technical refinement of OCR techniques in the areas in which they are now being used with success, that is, in postal applications, in publishing, in machine translation, and the like. But we would be interested in the reaction of readers, both from those who have used OCR systems, or are working with them, and from those who are now developing next-generation systems which we can consider as potential candidates to generate input to an automatic braille transcription system.

LASER CANE SAFETY TESTS*

Keith Kost

The Laser Laboratory of the University of Cincinnati Medical Center, internationally renowned for years for the study of the safe use of lasers, has contributed to the perfection of a laser cane to be used as a mobility aid by the blind. The existence of the laser cane, still very much in its experimental stages of development, was featured nationally in August 1970 by the National Broadcasting Company's television network. It was first announced in the publication Laser Focus in July 1969.

In 1969 Dr. Leon Goldman, director of the Laser Laboratory, volunteered the unit's skills in safety testing to the Research and Development Division of the Prosthetic and Sensory Aids Service of the Veterans' Administration which had begun by evaluating the laser cane. A cane was obtained by the Laser Laboratory.

Robert G. Meyer, Laser Laboratory project engineer, worked with Dr. William T. Ham, chairman of the Medical College of Virginia's department of biophysics, to determine the amount of radiation emitted by the three lasers in the cane. They used the sophisticated and sensitive devices of the biophysics department to measure the emissions.

Detailed studies on the safety aspect under working conditions were done also by Robert Epstein, directing engineer of the Laser Laboratory. Epstein's report to the Veterans' Administration stated that the cane has an extremely low rate of radiation emission well within the safe limits for human usage.

The laser cane, tested only for safety by the Laser Laboratory, was developed under Veterans' Administration sponsorship by Bionic Instruments, Inc., of Bala Cynwyd, Pa. At present there are 10 canes in existence.

Currently, the laser cane is still under investigation. When it is perfected, it will help the blind to detect objects ahead of, above, and below their paths- A pulse of 3- to 10-watt infrared coherent light emitted from three lasers, located just below the curved handle of the cane, is reflected from obstacles and detected by three photodiodes situated 9 inches below the cane's transmitters. The photodiodes are behind receiving lenses which focus the returning light beams. A sensory stimulator which produces a poking sensation on the index finger of a right-handed user is located on the right side of the cane between the transmitters and the receiving optics. This signal warns the user of hazards ahead. Easily distinguishable auditory tones warn of objects above and below. The cane may be rotated 90 degrees to gauge the width of obstacles ahead.

Goldman expressed the hope that, since its safety has been proved, performance programs to study this cane will be continued by sight instructors.

The University of Cincinnati Medical Center's Laser Laboratory, located in the Children's Hospital Research Foundation, has been active in numerous national and international laser safety endeavors. Safety courses and studies have been conducted for the Public Health Service, the Army, and the Air Force. Additional laser safety conferences are planned by the laboratory for 1971.

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*Reprinted from HSMHA Health Reports, 86(1):26-27 (Jan. 1971), Department of Health, Education and Welfare, Public Health Service, Health Services and Mental Health Administration.

BRAILLE MUSIC PROJECT

Robert S. Bray

The Librarian of Congress, L. Quincy Mumford, has announced the receipt of a $25,000 grant from the Kulas Foundation of Cleveland, Ohio, to begin work on a set of computer programs translating music notation into braille. The Kulas Foundation, established in 1937 by Fynette H. and E. J. Kulas, has supported many music projects. In making this grant it recognized the need for accelerating and increasing the production of braille music.

The Library's Division for the Blind and Physically Handicapped and the American Printing House for the Blind of Louisville, Ky., will work jointly in the preparation of computer-translation programs. It is estimated that this effort will take three years to complete.

Music became part of the Library's responsibility to visually handicapped persons, by law, in 1962. Over 2,000 blind musicians and music students borrow free of charge the limited number of music scores and instructional texts now available in braille and on discs, tape cassettes, and open reel tape through the Library's Division for the Blind and Physically Handicapped.

The Kulas Foundation grant will make possible the automation of procedures for producing brailled music, and hopefully will help to offset the shortage of highly skilled stereotypists who now translate music notation into braille manually.

The computer programs will facilitate the embossing of music by braille presses in multiple copies and will be used to make more classical and semiclassical musical material available. The Library's volunteer program, in which certain individual requests from students and teachers must still be transcribed by hand, will continue.

RESEARCH AND DEVELOPMENT IN SWEDEN, 1970

B. Lindquist

The following is an abstract of the annual report for 1970 of the Research and Development Department of The Swedish Association of the Blind. In the comprehensive and diversified work for the visually handicapped that is being carried out today there is a great need for research and systematic planning. It is the main task of our department to stimulate scientific institutions to find new ways and methods of reducing the effects of visual impairment.

This report contains summaries of results and descriptions of research projects in various fields and of various depth and character. Some educational and vocational development projects are also mentioned. The headings of the projects are as follows:

Research Projects

1. Educational investigations concerning the learning situation of the blind (summaries of 11 investigations).
2. The development of a sensibility test.
3. The visibility of the white cane in various traffic situations.
4. Typography for the partially sighted.
5. Factors influencing the rehabilitation of the visually handicapped.
6. Ideals and realities in the work for the blind.
7. The visually handicapped and the physical environment.
8. A computerized production system for Swedish braille.
9. The development of electromechanical equipment for the production of embossed diagrams and graphs.

Vocational Development Projects

1. The training of blind physiotherapists in Sweden.
2. The training of blind computer programmers in Sweden.
3. A training course for braille transcribers.

The Development of Educational Material

1. The development of an autoinstructional course in braille.
2. The development of set-theory symbols in braille.
3. Adaptation of a combined TV and radio course in psychology.
4. Adaptation of a combined TV and radio course in social science.

Planning and Investigation Work

1. The Swedish production of braille --an organizational investigation.
2. Revision of the adjustment program for the visually handicapped.
3. The planning of preparatory courses for blind university students.
4. The planning of an improved student service.
5. An analysis of the need for correspondence courses for the visually handicapped.

Further information about any item is available from our department.

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AN EXPLORATORY STUDY OF THE PLAY BEHAVIOR OF YOUNG BLIND CHILDREN*

Perla Elfrieda Tait

The Ohio State University, 1970**

The purpose of this study was to ascertain, by means of observation during an experimental situation, whether or not the play of blind children differed from that of peer sighted children. Twenty-nine legally blind children (fifteen males, fourteen females) within the age range of four years through nine years were presented with special play materials (a box, a stick, a hat, and a piece of cloth) during individual fifteen minute free play sessions. The play activities during this time were observed and documented. An equal number of seeing children matched for age and sex to their counterparts were similarly observed and their activities recorded. In order to establish a similar environment for all the children involved, the play sessions were conducted in a portable enclosure brought to each location.

The twenty-nine blind subjects selected for this study came from the following sources: seventeen subjects were attending the Wisconsin School for the Visually Handicapped, Janesville, Wisconsin; three subjects were attending the Minnesota Braille and Sight Saving School, Faribault, Minnesota; two subjects were attending the School for the Blind, Grand Forks, North Dakota; and seven subjects were contacted in their homes under the auspices of the Minnesota Department of Public Welfare, Services for the Blind, St. Paul, Minnesota.

The twenty-nine sighted subjects selected for the study came from the following sources: thirteen were attending the Minto Elementary School, Minto, North Dakota; ten were attending the Drayton Elementary School, Drayton, North Dakota; five were attending the Lincoln Elementary School, Grand Forks, North Dakota; and one subject was contacted in his home in Grand Forks.

The investigator reviewed all the information on each case and compiled narrative case records. These narratives were studied and a check sheet was developed which set forth quantitatively the significant information on each case which was subjected to statistical analysis. Information not suitable for statistical treatment was analyzed and presented in descriptive form.

The conclusions drawn from this exploratory investigation into the play behavior of young blind children were:

1. There was no substantial difference in the content, amount of time, complexity, and intensity of the dramatic play of blind and sighted children.

2. The blind children engaged in more manipulative play than the sighted children.

3. Blind children requested the involvement of the observer in play more frequently than the sighted children.

4. Blind children found difficulty in understanding the concept of a boundary as

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*Editor's Note: The following abstract of a Ph.D. dissertation was sent to us by Dr. Tait for publication. The complete document is available on microfilm at the Ohio State University, Columbus, Ohio.

**Now at The University of North Dakota.

illustrated by some of the aspects of their play.

5. Blind children asked questions more frequently than sighted children during play.

6. Intelligence, as indicated by the analysis of covariance statistic, did not exert any measurable effect on play behavior studied.

SPELLTALK: A NEW APPROACH TO READING MACHINE OUTPUT FOR THE BLIND

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ABSTRACT

Spelltalk is at least a new approach to the "intermediate" metalanguage problem that some have considered too difficult to solve. It is a 100 percent phonetic language which has but one sound for each printed letter and uses that sound wherever the letter appears. Thus the reading machine output is an audio code that is language-like in many of its aspects. The apparatus of Spelltalk is designed to produce the output portion of any other machine that recognizes letters or of any material especially prepared for it. The new approach may prove successful.

INTRODUCTION

The work on reading machine output at Carnegie-Mellon University is based on certain specific assumptions:

The system had to be inexpensive enough so that every blind person could have one easily available for his personal use. It had to be capable of reasonably high-speed output, so that the user could learn to comprehend it without undue effort. It had to have reasonably wide distribution among the blind if publishers and others were to go to much trouble preparing a wide variety of material for it. We concluded that economy was of paramount importance, so we made considerable effort to keep things simple while solving the numerous problems that arose. We should make it very clear that we are highly skeptical of complex or simple systems that require the use of the telephone, or require the blind person to leave his home to use central facilities of any kind.

Of three machines we have built, the latest is simple, appears to be comprehensible at high speed without an undue amount of training, and has been very enlightening to us relative to certain psychological and perhaps physiological parameters.

DEVELOPMENT

Spelltalk was the result of a logical train of intuitive feeling. For the system to be cheap and simple, it should have no (or at least very little) memory. It should have a rather simple, hard-wired set of reflexes. The machine had to make the audio code symbol for each letter as it came along -- at whatever speed the system was set. (With very minor extra cost a time delay of a fraction to one or two letter periods could be included.) Spelltalk is a code, and most codes are learned one letter at a time with speed of comprehension increasing in steps, as larger and larger groupings are learned. This task is normally long and difficult; even more difficult than it seems. Even if one can repeat or translate a code into letters rapidly, comprehension of the subject may be entirely missing. Thus, rapid spelling can be understood *as spelling* at 80 words a minute; it must then be learned as a language. To overcome this great barrier we assigned new names to the letters. The names were single sounds. The material was spelled at speaking speeds. This spelled output is what we refer to as Spelltalk. The single sound names were carefully chosen so that many words sound the same in Spelltalk as in ordinary English. Of course, it sounds like a machine not a voice. Nevertheless, the speech has certain human-like, somewhat subtle qualities without which we do not think Spelltalk would work.

Spelltalk does work, certainly not well enough yet, but it can be learned at speaking speeds. Since we can adjust pitch and speaking speed separately, we have tried it at as high as two hundred words a minute. It is still comprehensible as a language, but because it is not English Spelltalk must be learned. Because of that it cannot be judged without study.

UTILIZATION

A very legitimate question concerns the means of using such a machine. Particularly, what will it read? One input we had planned to use involved compositor's punched tape, such as produced by printers in typesetting, as a source. This machine readable tape would be translated into a more uniform system and distributed to the blind reader. Each printer has his own punched tape system. Almost any small computer could be set to read any of them and put out a uniform system. The sighted reader reads printed matter which is not "machine readable." We felt that for many or most purposes it was extravagant to require a machine to read it at this point in its processing, when it had previously been in machine readable form. The use of tape has been looked into (1970) with a slightly different purpose in mind by Grete M. Grunwald, Argonne National Laboratory. We do not think some of the problems, particularly tape errors, that she brings up are as important for our purposes as they may have been for hers. Grunwald is very concerned with the uncorrected errors in the tape. Of course their density is important, and may have much to do with conversion to braille, especially when the machine doing the converting must insert abbreviated notation wherever appropriate. For Spelltalk, however, this is certainly less important. The allowable error desnity will not be known until much more testing has been done. The sighted reader is accustomed to many errors, particularly in newspapers, yet he is not much upset by them, and the Spelltalk reader could probably do just as well.

If the code from the compositor is put on a microgroove record with 200 grooves to the inch and 500 information bits-per-inch of groove, each square inch of recorded surface could contain 3000 words. These numbers are on the basis of relatively low fidelity. A seven-inch inexpensive pressed plastic disc with cardboard backing could then have 60,000 words in one of its stereo channels on one side of the record. The other channel could be used for indexing. Many books, most magazines, and some newspapers would become available to the reader. The Spelltalk input machine would read the code from these discs which turn at very low speed. (Probably Talking Book players could be modified to act as the code reader.) The Spelltalk machine would then receive this code and would respond to it by producing the Spelltalk dialect output. (The pickup could be conventional, since the bit rate on the disc is rapid enough for that.)

Another source is the output of special typewriters, either the reader's own machine used for keeping notes or "carbon copies" of letters, or perhaps letters from the machine of a correspondent. A third source might be an optical scanner with letter recognition capabilities. Most of the latter are now either too expensive, or too slow to use Spelltalk at full capacity, but Spelltalk may still be the best match for the slow scanner.

PRINCIPLES

A problem of principle arises when we speak of machine-readable tape being translated into a more uniform code. It is clear that this would ordinarily be done by a small computer, which would also remove proprietary information such as type fonts, spacing size, and upper and lower case letters, etc. While doing this it could also, using a built-in dictionary, insert a few extra symbols to give better English (not Spelltalk dialect). This would require a somewhat more extensive Spelltalk machine, as perhaps 40 sounds would be needed. We think that in no case, however, could a simple machine really sound normal enough so that no learning would be needed. Furthermore, it takes more study to distinguish 40 sounds than 26, and 26 distinct sounds is difficult enough. Beyond doubt, however, our conclusions here are not founded on much more than prejudice. Our worry is that elaboration could make the machine not useful for carbon copies of ordinary English letters, or for scanning the printed page with an optical character-recognition system. At present we prefer the simple machine.

Spelltalk differs from English in several important ways. First, in constructing this artificial speech, it was necessary to choose specific sounds for letters. The usual sounds of the letters were preferred and, where no problem was involved, they were used. In some ambiguous cases, sounds not normally attributed to letters had to be assigned as the audio code. Usually the sounds of most frequent occurrence were selected, and in cases where two letters had the same sound the letter of most frequent occurrence controlled. Thus, the *S* sounds *s* and the *C* sounds *k*; *K* then had to be assigned a sound not normally associated with that letter. The sound chosen was *zh* as in vision. The word "talk" then sounds tālzh with the *a* having a long sound and the *k* sounding like *zh*. The letter *h* has its own unique problems. It appears in combination such as *sh*, *th*, *ch*, *ph*, *gh*, and is frequently silent. To make it sound speech-like, it was thought necessary to assign a vowel sound to it. The sound chosen was *aw* (ô), thus the word "the" sounds "tôĕ." The sound for "fight" is "fĭgôt" and, of course, "right" is "rĭgôt," whereas "write" is "wrĭtĕ." Words with *h* thus frequently have one more syllable, but this seems not to have been a problem.

Spelltalk is not spoken English, it is a code. We call it Spelltalk because it is spelling best learned at speaking speeds rather than at spelling speeds. Thus, Spelltalk and Spelled Speech are very different. Spelled Speech is audio code with one word spoken for each letter, compared to Spelltalk which has one letter sound for each letter. Spelled Speech is inherently slower than speaking, whereas Spelltalk is capable of being understood (in principle at least) at fast speaking rates. As we have said, one should not judge the sounds of Spelltalk on the basis of immediate comprehension at first hearing. This is the most important warning to beginners. It is essential to learn the dialect first. Ultimately, one can learn the dialect because the sounds of Spelltalk were chosen with the goal of most rapid learning in mind.

Of course, the sounds as used can be improved, but they are adequate now for initial tests. Some preliminary studies have been conducted which we will discuss later.

Many variations are possible and quite a few have been tried. For example, variations of the length of letter sounds have not been found useful, except that perhaps first letters of words should be longer. Therefore, all vowels are the same length, as no value was found in making long vowels long and short vowels short.

At first all the letters sound very much alike; distinction among them becomes easier with familiarity. The similarity in sound due to an overlying machine horn-like background which, though reduced in recent work, is still distracting. The beginner must become adjusted to the machine output which usually takes at least half an hour.

PRELIMINARY TESTS

Spelltalk has been produced and tested on a preliminary basis in a number of ways. In our first effort, we had two young women learn to speak this dialect. They were far from perfect but were able to converse without text within two weeks, and were doing a reasonable job of it. They supervised some preschool children in a play group and told them stories in Spelltalk. Actually, the Spelltalk was introduced gradually in play periods first. After a total of 45 hours exposure spread over a period of about three weeks the children were listening to stories in gradually increasing doses for 45 minutes at a time during the fourth week, and were laughing "on cue" and looking at the proper pictures. They were clearly understanding it completely. Of course, nonverbal communication was also at play here; the young women's intonations, facial expressions, and hand motions also conveyed ideas. In addition, the books being read had pictures. This was not a straightforward test of Spelltalk.

In our first Spelltalk machine, the sounds for the letters were recorded on sound tracks from which they were electronically selected according to the needs of the words being spelled (read). This early machine could work only at a fixed speed of ten letters- or spaces-per-second. A good deal of testing including blind persons was done first on this machine. The machine was a mechanical-electronic hybrid, and was expensive, though simple in concept. Two machines with fully electronic sound production mechanisms were then built, one after the other. The first of these electronic machines has been used in testing. The electronics of the first (though not the second) were modelled somewhat after the mechanisms of speech. The fully electronic machines have independent rate and pitch control, and the listener has some ability to adjust it to his needs. It is also clearly possible to use pitch and/or intensity or some simple scheme in intonation for punctuation.

The latest of our electronic machines is purely artificial, not following any physiologically based structural model. It is especially designed, however, to give important perceptual cues.

In testing we tried letter discrimination first, putting this in the form of confusion matrices. This early testing was undertaken largely to help us get better letter sounds. But even machine-made sounds have psychologically different effects when in different contexts. From single letter sounds we went to bigrams, trigrams, and syllables. Our primary finding was that testing is very tricky and we found reliance on intuitive response was better--or at least more satisfying. Comprehension tests were also difficult. We used high school reading comprehension tests, and we tested the tests. We found that bright students could do very well on them without having read the material. So we are still relying on our intuition.

Other schemes for audio output are possible, of course. Many have been tried. For example, some systems are very sophisticated with sounds that are very comprehensible in English--not a dialect. At the other extreme, some have tried code which does not resemble speech. Ours is an obvious middle-of-the-road choice that to our knowledge, has not been tried before. We think it has the possibility of being easily understood to a large enough number of potential users to make it an acceptable method.

We have tested the output of the second machine on blind persons and they found the sounds not unpleasant. Some even preferred them to professional readers for talking books. This is a little bit hard for us to understand but, nevertheless, we have gotten this response from more than one of the blind listeners. Not many of them have truly learned the dialect. Several people have listened for many hours, four (only one blind) have 40 hours or more. They were all "thinking" to some extent in the dialect. Several others who had studied about ten hours had moderate comprehension, but were not conscious of thinking in the dialect.

The different machines we built were individual enough so that one must learn specific machine output. This has not been studied, but it is assumed that it should not be a difficult task to learn the second machine output after the first is known.

CONCLUSIONS

Spelltalk must undergo much more severe and careful testing than has been done to date. The preliminary tests served some very useful purposes, however, as they were needed to develop the sounds. They also made us sharply aware of the great difficulties of quantitative testing. Since it seems that educational testing has never really been entirely successful in other fields, reliance on intuition was a reasonable first step.

Machines must be improved somewhat and some kind of testing must be utilized to see how to best "punctuate" the output. How can intensity and pitch be used most effectively when only very simple rules can be used?

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Editor's Note. Readers who are interested in hearing a sample of Spelltalk prepared by Dr. Longine and his colleagues are invited to write and ask for the cassette, playable on any Philips-type reproducer.

AN INEXPENSIVE, UNIVERSAL BRAILLE (UNIBRL)* OUTPUT DEVICE

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UNIBRL is an inexpensive, universal braille output device designed for blind computer programmers to read punched card, perforated tape, magnetic tape, microfilm, keyboard and inkprint electrostatic printer listing inputs, and to drive other braille and audio output devices.

In January 1964, Dr. Theodor D. Sterling of the Association for Computing Machinery (ACM) organized a Committee on Professional Activities of the Blind. This ACM Committee has been active in developing opportunities in computer programming for blind persons. The success of the ACM Committee is best exemplified by the over 150 blind persons successfully employed in computer work in the United States.

Rapid advances in the computer industry may seriously endanger the blind person's future in this new field. Hardware and software development trends (e.g. electrostatic printers; cathode ray tube, microfilm and other visual display outputs; magnetic tape-disk and perforated tape inputs; console debugging and on-line user interaction; remote keyboard-printer terminals) present major problems to the blind programmer.

Each hardware device has its own characteristic inputs and outputs which must be translated into a sensory modality (touch or hearing) which the blind person can use. In the past, the blind programmer was able to communicate with the Central Processing Unit via the punched card input and braille output of a mechanical high-speed printer. In the last several years many computer systems have changed from this classic form. New computer developments demand different and more general forms of solutions if the blind programmer is to survive in his occupation.

Punched card readers for blind computer programmers have been produced in this country and abroad. Inexpensive outputs are in columnar BCD form using raised pins, tones, or a stylus to sense the punched holes. Reading is slow and requires initial memorization of the different character codes. Braille cell outputs of raised pins, embossed dots, or vibrating bimorphs have been produced with an electronic diode matrix which converts punched card codes to their braille character equivalents. Reading is faster, but the electronics are inflexible, because they are designed for a fixed-format character code. A raised or indented scale along the card is commonly used to indicate the column number. Similar devices to read perforated tape have also been made. More sophisticated (and expensive) devices employing Spelled Speech audio, and embossed braille outputs from remote terminals have been demonstrated at MIT and other universities.

*Patent Applied For.

At present, the only commercially available Hollerith card reader is the Steubing mechanical reader, which sells for $115. A card is placed in a cavity over which a sliding cursor is indexed manually. The cursor has a vertical slot which is aligned with each card column. Punched holes are sensed by running a braille stylus down the cursor slot. The punched hole code is then converted mentally to its appropriate character.

The UNIBRL reader is an inexpensive, general purpose device engineered to be mass produced, to replace the card reader and produce braille and/or audio outputs from several different input types. The unique design feature of the UNIBRL reader is the changeable encoder disk, made by the blind programmer, from a universal pressure-ink template and blank disk. This allows him for the first time to adapt easily to different hardware input and output formats and thereby increase his effectiveness and job mobility.

The UNIBRL reader is a portable device designed to read by itself both punched card and perforated tape inputs at the rate of five characters per second, and to give stationary braille cell outputs of column numbers and character/function symbols. Four braille cells are used for column numbers and two for characters. An external input plug allows auxiliary devices to be connected to the reader to read magnetic tape, magnetic disks, microfilm, keyboard, and ink-print/electrostatic printer listing inputs. An external output plug also allows the UNIBRL reader to drive braille and audio output devices. The read-mode inputs (i.e. card, tape, or external) are selected by a three-position wafer switch. Any hexadecimal input-output can be converted by an encoder disk and electronics logic circuitry.

The reader measures 8 inches wide by 12 inches long by 2-3/4 inches high; it operates on 110 VAC and weighs eight pounds. The basic components consist of (1) Ledex Digimotor and Pulser; (2) Haydon timing motor; (3) 14 General Electric L14B light sensitive transistors; (4) International Telephone and Telegraph mechanical revolution counter; (5) encoder disk; (6) light bulb; (7) 7 Electromechanisms, Inc. SP-37 miniature solenoid actuators; (8) 3-position wafer switch; (9) heat sink; (10) LaVezzi drive sprocket; (11) power supply; (12) electronic logic circuitry; (13) 2 external plugs; (14) Precision Instrument Corporation gears and shafting; and (15) push buttons--all mounted on a common plate and protected by an aluminum chassis.

Since only 64 characters can be represented by the standard 3 by 2 braille cell, the character output must consist of two adjacent braille cells. The first cell consists only of "dot 6" or the "capital sign" (numbered 7), while the second cell contains all six dots numbered conventionally 1 to 6. It is possible to get 128 combinations with these seven pins, but only a maximum of 110 are used for perforated tape codes.

To read a punched card, it is loaded between spring-loaded rollers and registered on column number one. A perforated tape is read by threading it on to a drive sprocket. Auxiliary devices are read via the external plug connection. A second plug is used to drive other output devices. The column number is indicated by a four wheel mechanical revolution counter modified with braille numbers and geared to the indexing mechanisms. It counts from 1 to 9999 and may be reset to one by a complete turn of a reset knob (later models will feature a push-button reset). Indexing can be done manually or electrically with the Digimotor by simply pushing a button. Punched holes in cards or tapes are identified by common wire wipers contacting a printed circuit board. The holes are then compared electronically with the revolving encoder disk. When a code match is found, appropriate miniature solenoids are energized which push up pins in the character braille cell. The pins are held in position until the next index.

The encoder disk is a clear plastic blank the size of a 45 rpm record (i.e. 7-inch outside diameter by 1/16 inch thick, with a 5/16-inch diameter center hole). On this blank a universal precision 7-inch circular Cronar template, consisting of 180 equally spaced radial lines of ordered black pressure-ink dots, is centered and glued. The opaque dots are at the intersections of the imaginary radial lines and 14 concentric circles whose radii vary from 1-9/32 inches to 3-5/16 inches in 5/32-inch increments. The dot locations on each line are numbered radially from inside to outside: R_1, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, R_2. The radial lines are numbered counterclockwise 1 through 180 and denoted as L_1 to L_{180} respectively. The R_2 dots are 1/8-inch diameter; all other dots are 1/16-inch diameter. R_1 and R_2 are strobe dots for the electronic logic circuitry. The R_1 dot appears only once on L_1. The R_2 dots are on all (and only) even numbered radial lines. Dots 1 to 12 on odd numbered radial lines represent the different read mode (i.e., punched card, perforated tape, etc.) codes. Dots 6 to 12 on even numbered radial lines represent the corresponding braille cell dots 1 to 7, respectively, which is the braille cell equivalent of the preceding, adjacent read-mode codes.

The function of the logic circuitry in the UNIBRL reader is to compare the format code of the particular read mode selected with all the possible code combinations imprinted as dots 1 to 12 on the odd numbered radial lines on the revolving encoder disk. This is done with 14 photocells coincident and numbered identically to the dot locations. When the proper match is found it switches 7 (photocells 6 to 12, representing braille dots 1 to 7 respectively) of the 14 photocells used to scan the disk, and reads the braille code equivalent imprinted on the even numbered radial lines. The outputs of these seven photocells operate the solenoids which set up the various pins of the character braille cell solenoid bank.

By adding another solenoid, and using the AFWL 4 by 2 computer braille or "box braille" matrix (3 by 3 matrix with center dot always raised), 256 combinations are possible. The only requirement for the increased complexity is to make a larger encoder disk to handle 256 different punched card codes, or to use the same size disk, but miniaturize the dot size and spacing. The electronic circuitry would not be changed for either disk, but for the miniaturized version, faster, more expensive response photocells would be required. The present UNIBRL reader is optimumly designed for the L14B photocell.

Additional Laboratory Directors' Funds were requested to build a self-contained, portable audio and braille (AUDBRL) output-reader device employing principles developed for the UNIBRL reader. Instead of a 7-inch diameter revolving encoder disk, a 3-inch diameter by 9-inch long revolving, encoder cylinder containing 91 "compressed speech" film sound tracks, and the same UNIBRL black-dot code arrangement on its circumference, will be used. Output speed can then be increased to 30 characters-per-second, which will further increase a blind computer programmer's effectiveness. The UNIBRL reader inventor is presently investigating several state and federal prisons to see whether they have the capability, people, and interest to mass produce and service the UNIBRL and/or AUDBRL readers on a paid basis.

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Name: Audio-interrupter

Source: Paul Duke
224 Mimosa Drive
Cherry Hill, New Jersey 03034

Availability: Douglas Gee
10 East Second Street
Moorestown, New Jersey 08057

Price: $99.98

The device measures 12 x 3 x 6 inches. It has connections for receiving inputs from various sources such as Talking Books, tape recorders and/or radio and television. On the output side it has connections for headphones or earpieces and/or jacks for speakers (mono or stereo). Contacts are provided for three types of interruptions: telephone, doorbell and internal buzzer and/or intercom. When one of these is stimulated all sound in the headset, earpiece or speaker is cut and replaced by a buzzer tone specific to the source of interruption. A reset button permits the resumption of the interrupted audio output after the incoming signal has been dealt with by the listener.

Name: Braille Computer Terminal

Source: Richard Rubinstein
University of California
Irvine, California 92664

Availability: "One-off" working model at source. Program tape will be provided on request.

A teletype terminal was adapted to produce braille printout. It is connected to a "minicomputer" (Micro 811) which translates the signals from the large computer with which the user is communicating. Braille caps on the teletype keyboard allow the blind user to activate the machine. The system allows access to any computer available by telephone line.

Name: Braillemboss

Source: Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: From above, supply limited.

An automatic braille printer operated by electrical signals derived from one of many possible sources: it can be used slaved to an electric typewriter; as a terminal on a time-shared computer; or in stand-alone mode, with punched paper tape or magnetic tape input for small scale production of braille. It can operate at speeds compatible with either teletype or computer terminals.

Name: Braillemboss Interface Unit--ASCII(63)-ONE-CELL/DOTSYS Translator

Source: Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: From above, supply limited.

This translator operates with switch closures as inputs only, but in two modes: one translates the codes of the Model 33 or Model 35 Teletype into One-Cell braille: the other translates the special transmission codes used in DOTSYS into braille code.

Name: Braillemboss Interface Unit--ASCII(63)/ASCII(67)-ONE-CELL Braille Translator

Source: Massachusetts Institute of Technology
Sensory Aids Evaluation and Development Center
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: From above, supply limited.

This translator is designed to connect the MIT Braillemboss device with the Model 33, Model 35, or Model 37 Teletypes. It can receive either current-switching waveform or switch closures on each code level from a Model 35 "stunt box," or from an LRS 800 Receiving Selector. It has the ability to map lower case letters into upper case, so that a Model 37 Teletype can be used. It also includes a remotely controlled on/off switch which permits the computer to control embossing.

Name: Braillemboss Interface Unit--Translator for UPI Teletypewriter Code (TTY)

Source: Massachusetts Institute of Technology
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: Laboratory prototype

This translator is designed for the United Press International wire service 5-level Teletypewriter code. At present it accepts only switch closures from a tape reader. Circuitry for operation on the serial current switching waveform has been designed.

Name: Braille Verifier for Blind Typists

Source: Dr. I. M. Neou
Department of Mechanical Engineering
West Virginia University
Morgantown, West Virginia 26506

Availability: Experimental prototype

This is an electromechanical braille character producer operated from a typewriter keyboard. When a key is depressed, the typing bar, while on its way to the platen to type, closes a circuit leading to an electronic braille encoder. There the keyboard alphanumeric input is translated into braille code by means of a diode logic matrix. The energized solenoids at the embossing station actuate embossing pins, which in turn raise the appropriate braille display pins in a cell directly above them, forming the braille character. Seventy-five braille cells are deployed along a conveyor-type display belt, driven by sprocket wheels powered by a constant-force spring motor. Intermittent motions of the braille display belt and typewriter carriage are synchronized at a speed of 3:1 to allow for the difference in size between the letter and braille character spaces. On finishing a line the user can, by means of a crank, bring both the display belt and the carriage back to the beginning of the line for proofreading. Owing to the synchronization of the belt and carriage, when an error found in the braille display is brought back for correction, the corresponding ink print character is also located in the typing area.

Name: Ceci-Cruci-Cube

Source: Association Nationale des Parents d'Enfants Aveugles
74 rue de Sevre
Paris 7e, France

Availability: From supplier

Price: Approximately 100 fr.

A crossword game for the blind consisting of a grill frame and cubes bearing braille characters. The distribution of the braille letters is one vowel and four consonants to each cube, one character to each face of the cube. A guide mark occupies the remaining face. The game can also be used as an educational tool for children.

Name: Color Probe

Source: Dr. Cho Yuk Leung
University of Western Ontario
London, Ontario, Canada

Availability: Experimental prototype

Reflected light from a self-contained source in the head of the device falls on wide band photosensors. Output from the photosensors triggers oscillators whose frequencies are in the audible range; these are transduced by a small earphone, which presents the generated tones to the user. Basic red, green, and blue colors in scanned objects generate distinct notes of the scale. Grades of color are distinguished by combinations of tones. Rechargeable nickel cadmium batteries provide the 6-volt power required. The probe itself is at present thumb-sized, but further miniaturization is projected.

Name: Computerized Electronic Braillewriter

Source: Frank H. Myers
Bell Telephone Laboratories, Inc.
6200 East Broad Street
Columbus, Ohio 43213

Availability: Laboratory prototype

A braillewriter was modified for electronic control. Seven solenoids and seven contacts were added. An auxiliary keyboard was constructed to reduce operator fatigue and provide control pushbuttons. A controller housed in a single unit with the machine provides interface with the computer. The controller is a simple logic circuit that provides the sequencing for the electronic braillewriter, registers the data to and from the computer, and generates some special operator signals. The computer, a Redcor Corporation Model RC70, is a 16-bit, 860-nanosecond cycle time minicomputer.

Name: Dataflow Optical Page Reader (DFR-100)

Source: Datatype Corporation
1050 West 163rd Drive
Miami, Florida 33169

Availability: From supplier

Price: $9,450

The DFR-100 is a desk top unit weighing about 32 lbs., and is 9 x 23 x 22 inches in size. It operates on 117 v/ac ± 10 percent, 60 Hz and consumes approximately 20 W. The DFR-100 standard output provides parallel data signals, and status and control signals. The output code from the standard output may be either ASCII or BCD. All output signals are from TTL logic (SN7400) and are capable of driving up to five unit loads. The DFR-100 can operate at speeds between 8 and 60 characters-per-second. The reader will handle a variety of document sizes, up to 8.5 by 14.0 inches. The only physical constraints on the input format are the margin requirements. Each typed line of data must be preceded by a line start character; the optics system initiates the scanning process when it encounters this signal.

Name: Electro-Tacter

Source: Massachusetts Institute of Technology
Sensory Aids Evaluation and Development Center
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: Experimental prototype

The tactile panel meter features a movable tactual indicator with a scale, an audible indication of coincidence between tactual and visual indicators, and complete isolation both electrically and tactually between the meter movement and the read-out. The meter uses an API Model 371K Compack II controller whose basic movement is a contactless optical meter relay. A tactual scale is added to the meter below the set-point adjustment lever. A tone is used to determine the agreement of the location of the visual indicator, and the location of set-point adjustment lever.

Name: Insulin Syringe for Blind Diabetics (Revised Listing)

Source: G. A. Henke GmbH
7200 Tuttlingen
Kronenatr. 16
West Germany

Availability: From supplier

The originator of the syringe, Prof. Ir. R. G. Boiten of Technische Hoge-school, Delft, has devised a new model. The metal casing which provided the means to measure dosage has been replaced by a plastic casing. This has reduced cost and eliminated the need for repair. User life of the syringe is said to be 1 to 2 years.

Name: R.C.A. Radio and T.V. Audio-receiver

Source: Paul Duke
RCA/Information Systems Division
Camden, New Jersey 08101

Availability: R.C.A. Outlets or R.C.A. Sales Corporation
Indianapolis, Indiana 46201

Price: $79.95

The audio-receiver is a single unit with AM, FM, and all-channel TV. It is compact, self-contained, and was designed especially for use by blind and visually impaired. It comes with braille read-out symbols. The model has no external output leads for use within headphones, etc.

Name: Reading Machine

Source: Prof. M. Buyle-Bodin
Universite de Grenoble
Laboratoire d'Electronique
E.N.S.E.R.G., 23 rue des Martyrs
38 Grenoble, France

Availability: Laboratory prototype

The machine consists of three parts: the reading retina, an electronic processing unit and a mosaic of vibrators. For the retina, a matrix of 100 phototransistors grouped by lines and columns and consequently requiring only some 20 connections, was used. The functions of the processing unit are: amplification of signals from the retina to a threshold decision level; memory storage, since information from the retina is transmitted sequentially; transmission of activating commands to the tactual display mosaic. The display mosaic for the use of the blind reader consists of 100 vibrator rods which are activated to correspond to black areas of the reading material.

A parallel display of 100 light points is provided for the sighted experimenter or trainer. Introduction of letter recognition unit into this system is contemplated as a future development. This would permit a braille or other output instead of the present visual-to-tactile direct translation.

Name: Sonar Senser Cane

Source: Adams Enterprises Inc.
6800 Southeast Boulevard
Derby, Kansas 67037

Availability: From supplier

Price: $150

The cane operates on the principle of reflecting and receiving visible light from objects in close proximity to the cane. The more distant the object, the more steady will be the tone in the earpiece. At close range an object will produce an audio tone which varies in intensity. A constant background tone is heard until an object appears within range of the cane. The beam emitted by the cane is highly directional to enhance location of objects. The cane is equipped with tone and volume controls. Its weight is slightly under three pounds, including batteries.

Name: TAC-COM Communication System for Deaf and Deaf-Blind

Source: Massachusetts Institute of Technology
Sensory Aids Evaluation and Development Center
77 Massachusetts Avenue
Cambridge, Massachusetts 02139

Availability: Experimental prototype

TAC-COM is a portable receiver operating on rechargeable batteries. It presents a vibrotactile display to the user when it is energized by an induction field. The stimulus can be coded to meet many functional requirements. The system consists of a transmitter, which is attached to induction loops at a given location; and the receiver, which weighs less than 7 ounces, is carried on the person of the user. The coverage area is a function of the transmitter power fed to the loops. Any number of receivers can be used within a single coverage zone. A TAC-COM system is being evaluated as a doorbell and fire alarm device. Other applications projected are: end-of-line indicator for typewriter or braillewriter; telephone bell indicator; auditory cue indicator; light indicator; Morse code telephone communicator; and teaching aid and call system.

Name: Tactile Stimulator Array

Source: Stanford University and Stanford Research Institute

Availability: Telesensory Systems, Inc.
1130 Seena
Los Altos, California 94022

Price: $1750 (Fabrication upon order, delivery time 10 weeks)

The arrays contain a 24-row, 6-column matrix of pins that protrude through a finger plate. The spacings are sufficiently small to present the entire matrix to a single finger tip: column spacing 0.09 inch, row 0.0045 inch. Each pin is attached to a piezoelectric reed that requires only 2-mW drive power. The stimulation frequency is 240 Hz. Electrical contact to each reed is provided so that the pins can be electromechanically vibrated to display arbitrary tactile patterns. An electrical contact from each of the 144 piezoelectric reeds is brought out to a connector. At extra cost, drive transistors can be included that enable input pattern data to be multiplexed. Auxiliary circuitry can also be provided.

Name: Tactile Vision Substitution System (TVSS)

Source: Smith Kettlewell Institute of Visual Sciences
Pacific Medical Center
2340 Clay Street
San Francisco, California 94115

Availability: Experimental prototype

The fully portable model of this system weighs four pounds and operates from a battery belt. A coherent flexible fiber-optic bundle transmits the image from a small, one-ounce objective lens assembly, mounted on spectacle frames, to a one-pound TV camera carried on the shoulders or back. The video signal is dissected by an electronic commutator, and fed to an array of four-millimeter diameter coaxial stimulating electrodes. The electrodes are mounted as a matrix of studs in a flexible plastic conductor held elastically in contact with the skin of the abdomen. The stimulus is applied to the skin in point-for-point correspondence with the TV image. It consists of very short (10- to 500-usec) pulses of small constant current (1 to ma). The stimulus is pulse duration modulated in correspondence with the log of brightness at each point of the perceived object. This scheme makes perception of shades of gray possible.

Name: Vertical Brailler Computer Program

Source: Bradford Computer and Systems
New York, New York

Availability: From supplier

Price: Free

The Vertical Brailler, a computer program for formatting output, presents entire lines of printout by printing them vertically. A normal 132-character line requires five vertical pages. The program can also print horizontally, producing 40 characters-per-line. The braille is produced by the period on the print chain of a 1403 printer loaded with soft backing to produce the embossing. Input can be from tape or disc of any length. A truncation feature prevents repetition of any character more than three times, eliminating long gaps. To permit counting of spaces, periods may be inserted in all blank spaces. The program requires 9K bytes of core and a series 2400 mtu or 2314 disc, and operates under DOS/360 Version 21.

Name: Vibration Traffic Signal

Source: Seiichi Miyake
Traffic Safety Research Center
8-25, 1-chome Minamigata
Okayama-City, Okayama-Pref.
Japan

Availability: From supplier

An elbow-high aluminum cylinder is installed at pedestrian crossings and linked to timing of traffic lights. When the light signal turns green (go) a vibrator motor is activated. The vibrator can be made to turn off before the light changes to red (stop), thus providing a margin of safety for the pedestrian.

Name: Visual Assistance TV, Model 1 (VATV-1)

Source: Dr. Sam Genensky, Rand Corporation

Availability: Apollo Lasers, Inc.
6365 Arizona Circle
Los Angeles, California 90045

Price: $3,295

Magnification and display of the material to be read or written is provided by closed circuit television. Scanning across a 12-inch area is linked to movements of a lever adjustable for right or left hand use. Various magnification ranges are available, two being standard for each system. Controls are provided for focus, magnification change, scan position, brightness, contrast, and image reversal (from black on white to white on black). Fluorescent illumination is provided.

Name: Visual Assistance TV, Model 2 (VATV-2)

Source: Dr. Sam Genensky, Rand Corporation

Availability: Apollo Lasers, Inc.
6365 Arizona Circle
Los Angeles, California 90045

Price: $1,500 to $2,300 (depending on lens type)

Magnification and display of the material to be read or written is provided by closed circuit television. A movable table allows scanning by moving the material in the viewing field of the TV camera. Three different options are available for magnification: 1. a standard lens giving a fixed magnification of either 3x, 6x, 9x or 12x; 2. a zoom lens which permits continuously variable magnification from 2 to 12 times; 3. variable magnification from 3.5 to 15 times. Controls are also provided for focus, brightness, contrast, and image reversal (from black on white to white on black).

Name: Visualtek Read/Write System

Source: Visualtek
1830 Lincoln Boulevard
Santa Monica, California 90404

Availability: From supplier

This closed-circuit TV low-vision aid consists of two major parts: a camera system, consisting of a camera, zoom lens, and close-up lens, a camera mounting stand with viewing table light, a movable viewing table, an ac outlet box and master switch, and interconnecting cable for the second component, the monitor system. The monitor TV screen is available in several sizes, with or without a stand. A commercial black and white TV set can also be used instead of the specially designed monitor. The equipment is compact and portable.

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2. The "old" braille system.
3. The object of the revision.
4. The material.
5. The methods.
6. The work of research and results.
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8. The proposal for the revision.
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Date Due

DATE DUE	BORROWER'S NAME